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HUDSON SUPER SIX
TRADE NAME REG.

The Verdict on the Hudson Super-Six

THE Super-Six at this writing—May 25—has been on the market five months. Over 7000 of the cars are now running. The resultant demand exceeds anything ever known among high-grade cars.

All our general advertising on the Super-Six has been stopped for months, because of the over-demand. For months the Hudson factory has run in three shifts, 24 hours per day.

We have been steadily building new factory additions. Scores of big machines to equip them have been brought in by express. We are now equipped to turn out 4000 cars per month.

We prepared in advance for a doubled demand, but the demand for the Hudson has quadrupled. And every day increases it as new cars go into service.

Still the demand for the Super-Six is only beginning. It will be a year before men in general realize its supremacy. This has always been true, and will ever be true, of every great advance.

But the man who buys a fine car would do himself a vast injustice if he failed to get the Super-Six. A lesser car will mean years of regret. It will mean a car which is far outclassed in performance and endurance. It will mean less pride of ownership.

We urge you, for your own sake, to consider these things and to prove them.

HUDSON MOTOR CAR COMPANY
DETROIT, MICHIGAN

Suggestion No. 22

Costly Explanations

Many and many a retail car sale has been lost because the dealer had to "explain" the unknown speedometer on his car.

It can't be done, for car buyers know the Stewart—know that it is their safest guide as to the quality of a car as a whole—know that 95% of all car manufacturers use it as standard equipment—know that a manufacturer who doesn't use the Stewart is not willing to pay the little extra for quality.

Why buck the stone wall of public sentiment?

For every penny saved on a cheap speedometer, dollars are lost in retail sales.

Insist that the car you sell be equipped with Stewart Products.

"No car is better than its accessories"

The Stewart-Warner Speedometer Corporation

Chicago, Ill., U. S. A.

VOL. XXXIV NEW YORK—THURSDAY, JUNE 15, 1916—CHICAGO No. 24

S. A. E. Off On Lake Cruise

550 Members Leave Detroit on S. S. Noronic for Record-Breaking Summer Session—Complete Nomenclature Report Accepted—Dunham Is Nominated for President

MACKINAC ISLAND, MICH., June 13—*Special Telegram*—Just a little over 24-hr. old is the Society of Automobile Engineers' annual convention and midsummer meeting, but already it has written itself upon the annals of the Society as one of the most successful events it has ever held. To-day, at 3 p. m., the party landed at Mackinac Island and paraded ashore in groups made up by the six sections of which the Society is composed, and the members unattached to any of the geographical sections. Gayly-colored hats, bands and banners arrayed against the verdant background of historic Mackinac made a brilliant picture which will long live in the memories of those fortunate enough to be present. The vessel is running very closely to the schedule which had been announced and the professional sessions have been going on with methodical progress. The waters of Lake Huron have been exceptionally placid, the weather beautiful and the 550 members of the party have been enthusiastic over the success of the trip, which is only passing its first quarter with 3 more days to go.

Many Interesting Points

Mackinac Island offers some interesting points to the sightseer. Its historic forts and old Indian camping and burying grounds are still to be seen and the party of engineers soon covered the entire island, driving to the more removed points and searching out the places of interest. As the group paraded ashore a moving picture man recorded the antics of the party, so that those at home will have an opportunity of seeing what they were unfortunate enough to miss. The first affair was in the way of a get-together event in which the members of the party searched for various unknown Raffles who were disguised as ordinary members of the party. This served to make the party acquainted with each other, and in the evening after the professional session, there was dancing and later a midnight luncheon.

Meetings Well Attended

The engineering meetings are all well attended, the space on the observation deck being crowded at every session. After Russell Huff had made the principal address at the opening of the meeting yesterday, C. F. Kettering, engineer of the Delco company, gave a talk on the accomplishments in pure science within the last few years. His lecture, which served as a curtain-raiser, was far from abstruse and was very spectacular with experiments of a very interesting nature with such materials as radium and liquid air. Even some of the ladies found this talk so interesting that they lingered on the balcony above the speaker to watch and listen. This morning papers were read by D. D. Ormsby on Differential Substitutes, A. P. Brush on High-Speed Engines,

Herbert Chase on Possibilities of the Constant Pressure Cycle, and K. W. Zimmerschied read the paper by Professor Gallup on Car Performance. The discussions on these papers appear in the following pages.

Entertainments Planned

The boat is due to leave here at 5.30 p. m., and this evening, after supper, there will be an entertainment by the members of the Pennsylvania section and another by the Cleveland section. Henry Hess, on behalf of the Pennsylvania section, it is understood, will show his examples of color photography, an art which he has been experimenting with for some years. The entertainment of the Cleveland section is being kept a secret. After the entertainments a dancing contest will be held. Everything points at the present time to a highly successful convention from a social as well as from an engineering standpoint. The professional program is well arranged and the papers are of such importance to the industry and indeed, to the entire automobile-buying public that every engineer who could possibly afford to be on board is here or is represented. The eagerness with which the sessions are attended and the spirit of the meetings show that the importance of the program is realized, and in all probability by the time the vessel docks at Detroit next Friday, the entire program will have been gone through with, as arranged. To-morrow is a picnic day for the whole party with nothing scheduled except a day of enjoyment, and in all probability many of the members will take advantage of the opportunity to fish in the far-famed waters of Killarney and Georgian Bay. There will be a side trip on the steamer Waubic through the scattered islands in the bay, and also games and athletic contests, giving the engineers an opportunity to relax.

Important Standards Work

S.S. NORONIC, GREAT LAKES, June 12—*Special Telegram*—Punctuality has been the watchword of the first day's work of the largest meeting the Society of Automobile Engineers has ever held. With 550 members on board, the Noronic pulled out from the dock shortly after 3 p. m. and was well on her way to Lake St. Clair by the time the standards committee meeting was due to begin. The various committees of the Detroit section who undertook to care for the many needs of so large a party have done their work in a way that has earned the unstinted praise of every member of the party. On the lowest deck a theater has been arranged and it was here that the standards committee was called to order by Chairman Clayden this afternoon.

Nomenclature Report Accepted

Owing to the fact that the last meeting was held at the end of May, there have not been many division meetings, and no great quantity of new business was before the house. Reports had been prepared by the chairmen of most of the divisions, however, and one subject of the utmost importance was accepted by the committee. This was the complete report of the nomenclature division containing a name for every principal part of an automobile. The work of compilation has been difficult and has taken over a year of constant hard work on the part of the chairman of the division, K. W. Zimmerschied, of his many helpers and of the recorder, A. C. Woodbury.

Already the names chosen are appearing in the manufacturers' parts lists, and the old-time confusion should be a thing of the past before another year has gone. The ready way in which the industry has accepted the work even before it was complete is the greatest testimony to its value. On behalf of the electrical equipment division the most important parts of the report were a complete list of sizes and dimensions for flexible steel conduit for incasing electric wires. This includes fifteen sizes from 3/16 to 1 in. inside diameter.

Standard Headlamp Bracket

A standard headlamp bracket was accepted in three sizes which cover all requirements, this being first fruit of the sub-committee which has been at work on lamp standardization generally. It was reported that the sub-committee had conducted a number of tests of lamps and bulbs at the National Lamp Works and had discovered certain important facts with respect to the shape of filaments and reflectors. This work is to be continued and it is hoped to complete it by Winter. Other resolutions suggested by the lamp committee and accepted were: Sockets for bulbs should be so set in lamps that the pins on the bulb base are vertical; that lamps should be mounted not less than 3 ft. high, measuring from the ground to the center of the lamp, and *that dimming devices are not to be recommended for the purpose of eliminating glare.* Standards presented by the carbureter fittings division were accepted for throttle lever throw, for throttle lever rod ends and for gasoline pipe sizes, this phase being converted to pipe tap sizes for gasoline tube unions. The throw of the throttle lever end is to be as follows: 1½ for the three smallest standard carbureter sizes, 1¾ for the next five sizes and 2½ for the three largest sizes.

The electric vehicle division reported progress and recommended some specified dimensions for charging plugs which were accepted.

Speedometer Connection Standard Impossible

The miscellaneous division reported that the hoped-for standard speedometer drive connected had proved impossible at the present time. New recommendations accepted included standards for taper sockets for fender irons, the formula and standard dimensions for piston ring grooves previously reported, and an increase of ¼ in. in the length of thread of the standard S. A. E. bolt. Progress was reported in the many other matters before the division.

The iron and steel division added little to the report given at the Cleveland meeting. A new steel was added and it was also recommended that: It is inadvisable to advocate standard colors for designating steel bars in stock because the difficulties seem insurmountable. The number of permanent colors available is limited, and the range of steels large. As each user requires only a limited number of steels it is not so difficult for him to select colors adapted to his own needs.

From the other divisions only progress reports were presented, but these show great activity and many matters rapidly approaching the final report stage. There was little discussion on the reports which is testimony to the thorough work of the division.

Aeronautic Standards

Henry Souther spoke on the new division for aeronautic standardization, outlining the great need for standards in military machines. It is obvious that the other divisions of the standards committee will be kept busy by the consultative demands of the new division. Howard Coffin also spoke on the same subject, saying that there were 30,000 men being trained by the allied armies and that the allowance was four aeroplanes per man at the front. He added that the number destroyed daily was greater than all in America.

The evening session opened by President Russell Huff who made a short address.

Should Have More Members

He said that though the membership of the Society was now nearly 2000, this was far short of what it ought to be. At the council meeting held that morning the matter of affiliating some other allied societies with the S. A. E. was discussed. Mr. Huff said that the aeroplane, the passenger car, the truck and the tractor, even the motor boat, all had

much in common and that a natural bond bound together engineers in all these professions. There were about 900 different firms represented by the membership of the Society, and lists which had been compiled showed 5000 firms which could fittingly have such representation. At present the number of men per firm shown on the membership list was 2.2, though some firms had as many as ten representatives. Even figuring on only one per firm, the Society's roll ought to contain 5000 names. Continuing, the president thanked the different committees, mentioning that the membership committee had met with wonderful success; that the finance committee had the accounts of the Society in splendid condition, and that the standards committee was showing a still greater activity and doing most satisfactory work. He added that the excellent papers offered had gone far to increase the power and importance of the sections which showed a remarkable growth. Mr. Huff mentioned the fact that the war department had twice called upon the Society for conference work in connection with the army truck specifications, and that much good had resulted. He also drew attention to the fact that there were two past presidents of the S. A. E. on the naval consulting board, A. L. Riker and Howard Coffin, the latter also being chairman of the industrial preparedness committee, while a third past president, Henry Souther, was consulting engineer to the aviation corps by government appointment.

$47,000 in the Treasury

Concluding his address, Mr. Huff called upon Herbert Chase to read the treasurer's report. This showed a balance in hand of $47,000 and contained the information that unexpected demands upon the funds had been more than met by uncalculated increase in the membership. Mr. Chase stated that the finance committee hope soon to be able to place all initiation fees in the reserve fund as is done by some other societies. Meanwhile a considerable sum is being held as a reserve.

1910 Members

Next came the report of the membership committee, read by R. C. Combs. This was a brief statement showing that the present membership was 1910 with ninety-seven applications on file. This is considerably higher than the previous high-water mark of 1852 in 1914.

Nominations of Officers

George W. Dunham, consulting engineer, was nominated for president of the Society for the coming year with J. G. Vincent, Packard Motor Car Co., as vice-president, and B. B. Bachman, Autocar Co., and F. E. Moskovics, Nordyke & Marmon Co., as councilors. Herbert Chase remains treasurer. The nominating committee held at the business meeting consists of K. W. Zimmerschied, Detroit section; F. E. Place, Mid-West section; G. P. Dorris, Indiana section; E. S. Foljambe, Pennsylvania section, and David Fergusson, member at large.

Before closing the business meeting, two presentations were made. K. W. Zimmerschied was made a life member of the Society without the payment of further dues, in recognition of his valuable work as chairman of the standards committee up to last January. Captain Foote of the steamship Noronic was presented with a clock as a token of friendship and admiration for the masterful way in which he has handled his vessel on the S. A. E. cruises and for his seamanship in negotiating the tortuous and rocky passages of Georgian Bay with the large steamship.

A movement being on foot to ally the activities of the Society with the marine, tractor, stationary and aeronautical fields may mean the addition of four vice-presidents to the governing staff of the organization and two additional members of the council. The societies which represent the activities of these four kindred industries have made a move toward consolidation with the S. A. E. and this gives prominence to the thought that in a very short time the membership of the Society will be greatly increased and its power and influence also greatly expanded.

Kettering Opens Professional Session

Never has a more interesting talk been given the Society than that by C. F. Kettering, Delco engineer, in opening the professional session. Mr. Kettering offered the rare and happy combination of a fascinating subject and a clever lecturer, and consequently kept the 300 attending members spellbound as he led them through some of the wonderful developments in materials recently obtained through the medium of pure science. He spoke of how our close attention to the work of production has allowed us to forget to a large extent the work of the experimental scientists who are forever searching through the medium of pure science for new materials and new methods. As a concrete example he mentioned alloy steels and rubber. Our cars would be ponderous affairs if it were not for the alloy steels which compose the principal parts. It would be impossible to make them anywhere near as economically if it were not for the alloy steels that are necessary in the tools that turn out the metal parts. Vulcanization was discovered in the laboratory and from this seemingly unimportant discovery the entire art of rubber working with all its importance to the human race came into being. Another simple discovery, if regarded superficially, was that of mixing tungsten with other metals. This discovery has revolutionized the manufacture of automobiles, as it is the basis of high-speed steel, without which present manufacturing schedules would be impossible. Mr. Kettering related the development of the tungsten filament lamp. He spoke of how it was once a draw between the Welsbach gas mantle and the electric lamp. The question was to secure more light for the same expenditure of energy. The carbon lamp was improved and then the tantalum lamp was introduced. This in turn was succeeded by the tungsten filament. The carbon filaments were first manufactured by squirting cellulose through a die and then carbonizing the cellulose. After this the cellulose was removed, leaving the carbon filament. The reason of this method of manufacture was that the filament was very fragile and of unequal thickness with the reason that its life was short and great care had to be used to protect it against jar and vibration.

When the tungsten arrived it was first manufactured by the same process, being mixed with a binder and then squirted through a minute opening. The binder was then removed, leaving the tungsten filament. This was very delicate and had to be handled with the greatest amount of care, but it did have three times the illuminating power for the same amount of energy consumption.

Drawing Tungsten Wire

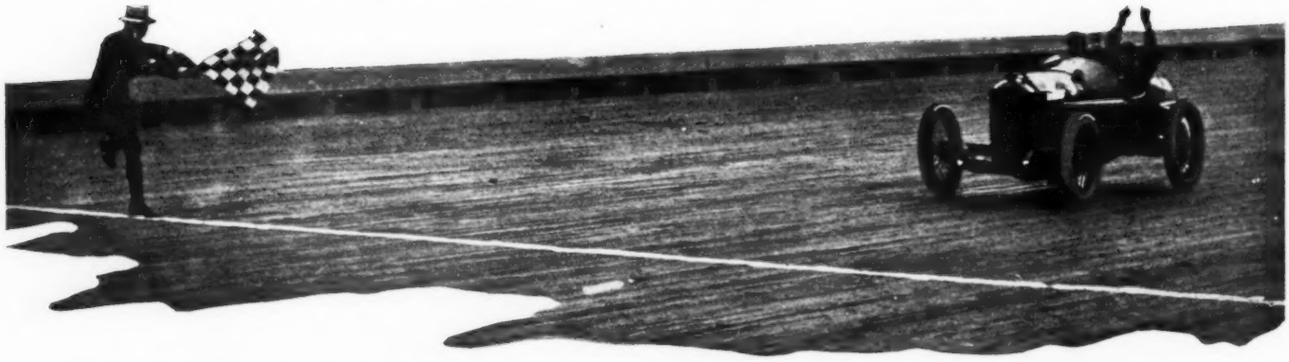
How to draw the tungsten into a wire filament was the next subject of study. In order to make the dies it was necessary to pierce the diamond—the only material hard enough—with a hole 2/1000 in. in diameter. This was finally accomplished and the experimenters were at last able to produce 2200 ft. of wire before the die broke. The bulbs at first were made of vacuum type, but it was discovered that if an inert gas were introduced into the bulb the illumination was greater, hence nitrogen was used. But it was discovered that after a while the nitrogen went into combination with the tungsten, forming nitrides of the metal, so that now argon is used. Without tungsten we would not have the wireless telephone receivers which allow us to talk nearly across the Pacific Ocean.

Bakelite was the next example of a new material. Mr. Kettering spoke of how it had been discovered in the laboratory, that two chemicals—carbolic acid and formaldehyde—if heated under pressure, reacted together to form a new

(*Continued on page* 1103)

Resta Captures Chicago Derby

Covers 300 Miles in Peugeot at 98.7 M.P.H.—De Palma Second After Terrific Speed Duel with Leader—Christiaens Third in Sunbeam



Resta, in the Peugeot, getting the checkered flag as he roared across the finish line, winner of the Chicago Derby

CHICAGO MOTOR SPEEDWAY, June 10— By L. V. Spencer

Thundering over the finish line in his blue Peugeot, Dario Resta, fresh from winning the Indianapolis classic, to-day repeated his victory of a year ago in capturing the 300-mile International Derby on the Chicago speedway at an average speed of 98.61 m.p.h., his time for the three centuries being 3:02:31.64, or bettering his last year's mark made here, when he covered this distance at an average speed of 98.2 m.p.h. Although no speedway records fell before the onslaught of the French-built racer, Gil. Anderson's mark of 102 m.p.h made last Fall in the Stutz at Sheepshead Bay still standing, the thrilling battle of brain, muscle and machine between Resta's Peugeot and De Palma's Mercedes will long be remembered by every one of the 90,000 spectators who thronged the stands and field.

Although Resta added another to his list of victories, neither he nor the crowd was sure of that victory until there remained but two laps to go. Ralph De Palma, driving his cream-colored Mercedes, seemed to be about as certain to get the checkered flag first as did the eventual winner, until a spark plug interfered in the 296th mile.

Resta and De Palma had been fighting, fighting for over 150 miles, almost hub to hub the entire time, and it looked as if the winner would lead by less than a car length, when on the back stretch the eager crowd saw De Palma slow down and Resta shoot ahead as he had not been able to do since he had left the procession and come into the front rank back in the 120th mile of the race.

Then the crowd knew that De Palma's jinx had come to him again, just as it did in 1912, when, in the Indianapolis 500-mile race of that year, he had been robbed of practically certain victory with about two laps to go because of a broken piston.

De Palma, who finished second, snapped with Resta, the winner, after the race. De Palma, who drove a Mercedes, has his hand on Resta, Peugeot pilot

And to-day, as on that day 4 years ago, De Palma proved himself to be the gamiest of the game. For he smiled philosophically as he rolled by in second place, after having stopped at the pit to change that $6,000 spark plug on his green-flag lap. De Palma has tasted defeat before when victory was almost within his grasp, and he knows a race is not finished until the last lap has been completed.

De Palma covered the 300 miles in 3:04:25.37, or at an average speed of 97.6 m.p.h., and was well ahead of Christiaens, who was third in a Sunbeam, one of the two English sixes which were among the staunchest in the race. Christiaens made the three centuries in 3:07:55.48; and less than a minute behind him was O'Donnell in a Duesenberg, who finished in 3:08:30.46, at an average speed of 95.48 m.p.h. Next came Galvin in the other Sunbeam, whose time was 3:10:23.45. Close on his heels was Vail driving a Hudson, about 7 sec. behind, with a time of 3:10:30.65.

The other four who came within the money were farther apart, although all were running well as they crossed the tape for the last time. D'Alene, driving the Duesenberg that gave him second money at Indianapolis this year, drove it to seventh place to-day, finishing in 3:13:2.85. Two minutes later Gable ended his grind in a Burman Special, with a final time of 3:15:51.31; and ninth place went to McCarthy in another Hudson Special, doing the distance in 3:19:10.73. He had about a 5-min. lead over Lewis in the Crawford Special, the latter getting tenth money with a time of 3:24:58.07.

Oldfield Goes Out Early

Early in the race Barney Oldfield looked to be a serious contender in his shiny blue Delage, but it broke a driveshaft after 18 miles and left the veteran driver a

spectator. Eddie Rickenbacher, who was among the first three for over 100 miles, and who was driving Mulford's Peugeot, was forced to drop out with a broken valve after he looked to be a favorite with many for first money. After the withdrawal of all of the Indianapolis cars on Carl Fisher's edict against Sunday driving, Rickenbacher, who was to have driven his formidable Maxwell, received permission to drive Mulford's car, the latter also having scruples against contending in a Sunday race.

Winners of Chicago Derby

Car	Driver	Time	M.P.H.	Prize
Peugeot	Resta	3:02:31.64	98.70	$13,000
Mercedes	De Palma	3:04:25.37	97.60	6,500
Sunbeam	Christiaens	3:07:55.48	95.78	3,000
Duesenberg	O'Donnell	3:08:30.46	95.48	1.500
Sunbeam	Galvin	3:10:23.45	94.54	1,300
Hudson	Vail	3:10:30.65	94.48	1,200
Duesenberg	D'Alene	3:13:02.85	93.24	1,100
Burman	Gable	3:15:51.31	91.90	900
Hudson	McCarthy	3:19:10.73	90.03	800
Crawford	Lewis	3:24:58.07	87.80	700

As is always the case, the winning cars made the fewest pit stops. Resta stopped only once, changing a right rear tire and taking on supplies of gasoline, water and oil. This was in his 121st mile. Likewise De Palma had been forced to make but one stop up to the time his spark plug trouble came. In his 105th mile he stopped for a left rear tire change and for supplies, and it looked as though he was going to equal Resta's one-stop record when his disappointment came. Coming slowly back to his pit after ignition had cost him a possible $6,000, he lost no time in removing the defective plug and getting away again for second place. But it was too late, when he was under way once more, for him to catch the fleeting Resta.

Twenty-one Starters in the Race

Twenty-one cars started. Starter Wagner and his able coadjutor, Chairman Edwards of the technical committee, gave each driver his position, and then final instructions were doled out to each crew. Amid stirring music from the band, drivers, mechanics and officials lined up before the camera men and moving picture operators for the customary photographs. Then, with De Palma as the pacemaker—he had the pole—the cars circled the track once at a mile-a-minute clip, and being fairly well bunched when they again passed the line, the signal was given and they were off for Chicago's second race and perhaps one of the most thrilling speed duels the sport has ever known.

The crowd knew it would be a fierce struggle between Resta, De palma and Rickenbacher, at all times mindfull of the stamina of the English Sunbeams, of the dark-horse possibilities of Oldfield and the fight that was in the Duesenbergs. Never was a gathering of over 90,000 persons treated to greater thrills than in the terrific speed battle that was to follow the thrillingly swift send-off.

Resta Takes the Lead

At 20 miles Resta was in the lead, with De Palma about half a lap behind and O'Donnell in his Duesenberg a close third. Back of him came Rickenbacher, driving in characteristic style, and then the two Sunbeams appeared, Christiaens leading his team-mate by a few yards. The rest of the field was spread out somewhat; but before another ten laps had been covered Rickenbacher was stepping on his accelerator and climbing toward second position, fighting it out strenuously with Resta. O'Donnell was a little ahead of De Palma, now in fourth place, and the Sunbeams hung together fifth and sixth. Several of the drivers were doing their utmost to capture the coveted first position but others hung back for strategic reasons.

Rickenbacher in the Van

Driving at a terrific pace, Rickenbacher forged into the lead and Resta, perhaps a little more conservative, clung to his set pace just behind, leaving the others in about the same relative positions they had held 20 miles before. But O'Donnell had to stop for a tire change and this put him in seventh place at 80 miles, with Resta leading and Ricken-

Sending off the cars in the running start of the 300-mile International Derby on the Chicago Speedway

Times Made by Cars in the Chicago Derby at 20-Mile Intervals

Car	Driver	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	M.P.H
Peugeot	Resta	12:09	24:05	36:11	47:52	59:34	1:11:15	1:25:54	1:38:04	1:50:10	2:02:16	2:14:26	2:26:35	2:38:41	2:50:43	3:02:31.64	98.61
Mercedes	De Palma	12:11	24:21	36:24	48:35	1:00:43	1:13:59	1:25:55	1:38:04	1:50:13	2:02:17	2:14:26	2:26:32	2:38:40	2:50:42	3:04:25.37	97.60
Sunbeam	Christiaens	12:25	24:48	37:19	49:44	1:02:04	1:14:23	1:26:36	1:40:14	1:52:25	2:04:46	2:17:16	2:30:04	2:42:54	2:55:28	3:07:55.48	95.78
Duesenberg	O'Donnell	12:11	24:17	36:20	50:19	1:02:38	1:14:52	1:28:37	1:40:46	1:52:51	2:06:45	2:18:49	2:32:43	2:44:41	2:56:39	3:08:30.46	95.48
Sunbeam	Galvin	12:40	25:06	37:25	49:45	1:02:05	1:14:24	1:26:41	1:39:03	1:55:17	2:07:32	2:21:20	2:33:55	2:46:08	2:58:14	3:10:23.45	94.54
Hudson	Vail	12:48	25:36	38:23	51:01	1:03:25	1:15:08	1:29:51	1:42:14	1:54:44	2:07:10	2:19:37	2:32:28	2:45:15	2:57:56	3:10:30.65	94.48
Duesenberg	D'Alene	13:26	25:34	37:42	49:53	1:01:54	1:16:23	1:32:01	1:44:49	1:56:09	2:08:25	2:20:33	2:32:57	2:48:23	3:00:41	3:13:02.85	93.24
Burman	Gable	12:48	25:38	38:47	51:32	1:03:59	1:16:21	1:28:36	1:40:58	1:53:31	2:06:26	2:23:22	2:35:44	2:48:12	3:01:47	3:15:51.31	91.90
Hudson	McCarthy	12:51	25:39	38:21	53:01	1:07:40	1:21:37	1:34:42	1:47:23	2:00:11	2:12:55	2:25:42	2:38:26	2:51:22	3:06:04	3:19:10.73	90.03
Crawford	Lewis	14:00	26:35	41:34	54:02	1:06:32	1:20:08	1:32:25	1:44:43	1:57:11	2:09:40	2:24:26	2:37:03	2:49:22	3:05:32	3:24:58.07	87.80
Peugeot	Rickenbacher	12:11	24:06	36:11	47:53	59:35	1:11:14										

bacher at his heels. De Palma then went into third position, and for the next 40 miles the three tore along, alternately striving to get the pole so as to gain the advantage. The illustration at the top of the opposite page gives an idea of this excitingly close struggle.

De Palma Grasps His Opportunity

Trailing the two Peugeots, which were fighting it out for the lead, Resta having it at 80 miles and 100 miles and Rickenbacher getting the upper hand at 120 miles, De Palma soon had his chance to come to the front. Like the super-driver that he is, he soon saw his opportunity. Having stopped at his pit on the 104th mile, where he replaced a tire and took on oil and gas, he was driving like mad to regain lost ground, when suddenly Resta hove in sight and limped to his pit. Thïs was in his 120th mile, and a right rear tire was the cause. But before he could get away Rickenbacher, too, stopped, he being in the lead and on his 122d mile. This was De Palma's chance. With the two Peugeots at a standstill, he put on some more speed and clipped many seconds off the gap between himself and the Peugeots.

Rickenbacher Is Out

But Rickenbacher was not to trouble him further. A broken valve meant that the race would be between the cream-colored Mercedes and the blue Peugeot. Resta was soon on his way again, and then the day's real excitement began. Almost from that minute the immense crowd was treated to real racing. It was the kind they had paid to see, and one minute Resta had the lead, then De Palma, by a master spurt, had overtaken him. The spectotars never knew which car would be ahead until they were directly in front of them.

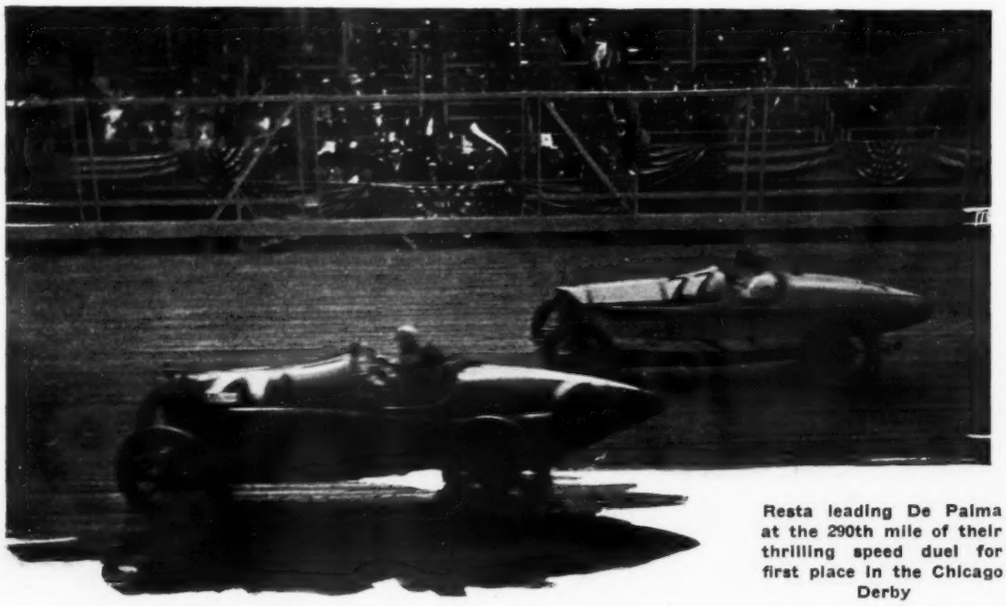
A Terrific Speed Grind

On they sped, lap after lap; now Resta was two car lengths ahead of the Mercedes, now he was trailing it by the same amount or more. It was evident to all that if they kept it up it was simply a matter of which car would withstand the grind the longest. At 280 miles De Palma took the lead again, after Resta, by terrific bursts of speed, had snatched it from him time and again. There never seemed to be much advantage for either car; they passed each other at intervals amid the cheering of the crowd.

Resta Regains First Place

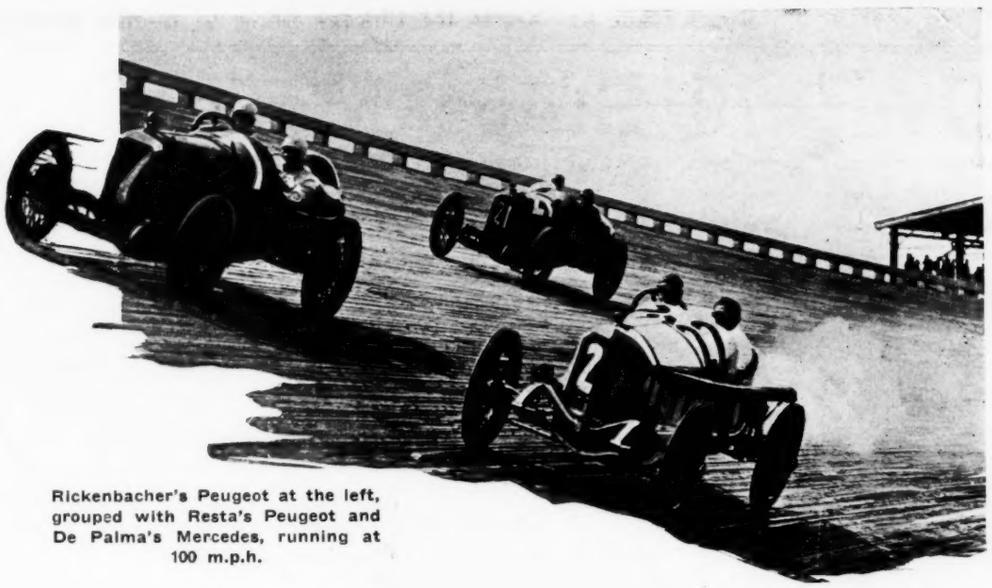
The rest of the field, all running well, was forgotten for the time being in the breathless excitement of that great duel of speed and nerve. Now another car would get in the way of De Palma and he would bow before Resta's better position on the track or the turns; then Resta would have to relinquish his place to De Palma's more advantageous location.

With only 24 miles more to go, and with neither driver able to shake off the other, it promised to be a finish the like of which American speed fans had never before witnessed. But De Palma was allowed to hold the lead for only 6 miles more, when Resta again forged ahead on a terrific sprint on the home stretch. For 10 miles more Resta clung to his place by barely a car length. It seemed as if the Mercedes would run into its rival at each moment, until at the tape on the 292d mile they were almost abreast, De Palma getting the lead at the turn by nosing the Peugeot out of the pole position. Now De Palma had the race, the crowd thought; but, almost as they said it, the Peugeot was seen to



Resta leading De Palma at the 290th mile of their thrilling speed duel for first place in the Chicago Derby

shoot ahead on the back stretch. Something had happened to Ralph, for he slowed down in front of the far grandstand and came home to his pit at a moderate pace. All was over, for there was no stopping Resta. Almost before De Palma could change the plug that had done the damage Resta had the green flag, and a few seconds later was cheered as the winner once more.



Rickenbacher's Peugeot at the left, grouped with Resta's Peugeot and De Palma's Mercedes, running at 100 m.p.h.

Sunbeam Third

Christiaens, who had clung to third place ever since his 180th mile, was quick to see his advantage and gave his mount every ounce of speed it had in an effort to take the unfortunate De Palma's lead away from him for second money; but the Mercedes was too far ahead for that. The Sunbeam proved itself a car of stamina, for it covered the distance with much credit and had reserve power for a brilliant finish. O'Donnell's Duesenberg also made a great showing. Taking the fourth position away from Vail's Hudson in the 240th mile, it held to its acquired berth to the end. Galvin's Sunbeam also bested Vail in the last 20 miles for fifth money, but the Hudson was not to be shaken from sixth position.

Two Cars Flagged

Only one other car finished the full 300 miles. This was Buzane's Duesenberg, which came in eleventh and at least had the credit for going the distance. Two cars were flagged —Johnson's Crawford, on its 290th mile, and Henning's Ogren, at the 246th mile. No accidents marred the day, leaving Chicago's track still unblemished by a fatality. There was a chance for trouble, however, when Galvin's Sunbeam skidded just after finshing its last lap and on the southern turn. The car whirled around and crashed into the inner guard rail, but neither driver nor mechanician was injured. Henning threw a tire on a turn also, but he retained control of his machine.

$30.000 in Prizes

The cash purses amounted to $30,000. Resta won $13,000; De Palma, $6,500; Christiaens, $3,000; O'Donnell, $1,500; Galvin, $1,300; Vail, $1,200; D'Alene, $1,100; Gable $900; McCarthy, $800, and Lewis, $700. Of the $500 prizes for leaders at 100, 200 and 250 miles, Resta secured two and De Palma one, for his lead at 250 miles.

Too Many Tire Changes

Studying the tire situation, as developed in this race, one cannot but feel that too many tires are blown in these races. Tire changes before the shoes were actually blown were down around 10 per cent of the total. It not only endangers the drivers, but also the cars when these shoes are blown on the turns at speeds around 100 m.p.h. The tendency for the car to spin about one of the wheels is great, especially on the cars fitted with the heavy and long tails which carry the center of gravity some distance to the rear.

Nineteen Right Rears Changed

A right front shoe, blowing at a critical moment, makes the car very difficult to handle in the counter clockwise direction used in the races. There were five right front tire changes in the race and all of these were blown. Of course the majority of changed tires were right rears. A total of nineteen of these were made, of about two-thirds of all the tire changes. This is lower than the average percentage in these races where generally over 75 per cent are right rears.

Too Much Smoke

Another feature which may be criticised is the over-lubrication which was common, to the detriment of plugs and valves and the enjoyment of the spectators. The smoke was particularly bad when the cars drew up at the pits and, naurally, in getting under way. At times the track was clouded over to such an extent that it was difficult to drive through.

—

Resta Adds 900 Points to Lead for Championship

22 DRIVERS COMPETE FOR HONOR

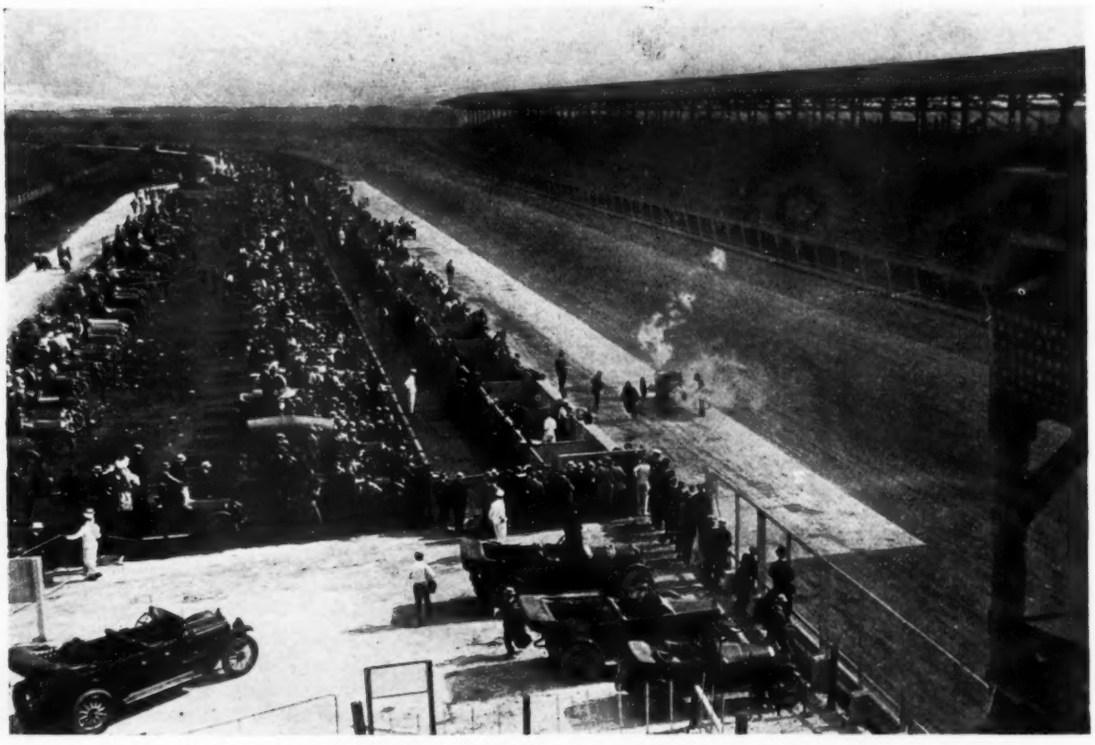
NEW YORK CITY, June 12—A total of 1800 points is placed to Dario Resta's credit in the championship table of 1916. By winning the 300-mile race at Chicago yesterday, 900 points more was added to a like number made by winning the 300-mile race at Indianapolis on Memorial Day. So far he has a tight grip on the title of champion driver of the year and for the leader's share of the $10,000 purse hung up by the B. F. Goodrich Co. and the $3,500 donated by the Bosch Magneto Co., including the $1,000 Bosch trophy.

Resta has increased his lead over Rickenbacher by 1185 points, the latter adding only fifteen points in the Chicago race in which he was placed in eleventh position. D'Alene held on to third place and De Palma moved into fourth place. Christiaens passed Vail, Mulford and Devigne by recording 240 points more, thus pulling him from seventh to fifth place in the table.

Twenty-two drivers now figure in the championship table, the standing being as follows:

Resta	1800	Galvin	80
Rickenbacher	615	Adams	55
D'Alene	510	Wilcox	40
De Palma	470	Watson	35
Christiaens	370	Gable	30
Devigne	320	Johnson	30
Mulford	240	Chandler	25
Vail	220	McCarthy	25
O'Donnell	130	Henderson	22
Devlin	90	Haibe	20
Oldfield	80	Lewis	20

Over 70 Stops Made at the Pits



The pits at the Chicago Speedway during the race. Resta is stopping for gasoline and tire

OVER seventy stops at the pits made this one of the liveliest races that has ever been witnessed from a technical standpoint.

Twenty-nine worn and blown shoes were changed, fifteen stops were made for gasoline, eight for plugs, eight for water and eight for oil. The other miscellaneous stops including those which from their nature were permanent totaled fifteen.

Henning was king of the tire changers, as he went the entire circuit on his car, changing both fronts and both rears in rapid succession and then shortly afterward changing the right rear twice again, making a total of six tire changes. There never was any doubt about his having to change any of his shoes either, as they generally resembled a bunch of rags whenever he rolled up to the pits to make a change.

Oil Adjustment Important

Outside of tires, the question of oil adjustment is the one that had the most to do with success or failure. A little too much oil meant sooted plugs which soon brought cars to the pits for time-consuming changes; a little too fine an adjustment meant burned and seized bearings which destroyed the chances of the car permanently. Thus this question of oil adjustment is paramount. It varies even with the track, and it is the one point upon which all the drivers have to work with the keenest appreciation for conditions in the race, in order to keep the car on the track and away from the apron along the pit wall.

The eight stops for plugs represent a very small percentage of the cars, as three of these were made by Johnson in his Crawford and three by Buzane in the Duesenberg. Thompson also stopped once for a plug change and De Palma, with the demon of ill-luck still pursuing him, had to make a plug change when he had an even chance for first money. The delay cost him the opportunity for the final battle across the finishing line and spoiled what should have been the prettiest sprint ever seen on a speedway.

Eight stops were made for oil. Altogether the drivers played on the generous side with the oil supply. The smoke on the track was more than has been seen in some time and very often the officials were almost in doubt whether or not to rule off cars that gave forth too much of the blue-gray vapor. The race was only a few minutes old when Tom Alley was flagged off for excessive smoke.

Few Stops for Water

A sidelight on the plug changes of Buzanne may be noted in his stops for water. These also numbered three, and from the two factors, plugs and water, it can be inferred that overheating was the cause of the stops made by him. This trouble was due to the fact that the packing gland at the water pump connection was leaking.

The greatest number of stops during the day was made by Henning in the Ogren. He drew up at the pits nine times.

Barney Oldfield was out early in the race. For some time he was in doubt as to the exact nature of the trouble, but finally traced it back to the transmission drive members. Broken connecting-rods destroyed the chances of Thompson, Rawlings and Watson. A broken valve put Mulford's Peugeot driven by Rickenbacher out of the running and finally, Frank Galvin broke a steering link on his last circuit and crashed through the retaining wall into the infield. Luckily neither he nor his mechanic were injured.

Haibe in the Osteweg started with a sticking valve and ended prematurely with the same trouble. He rolled into the pits several times to apply oil to the stem of the valve, but the sticking finally became so bad, due to the added expansion when the motor became hot, that he had to withdraw.

Equipment and Specification Details of Cars in 300-Mile Chicago-Derby

Car	Driver	Bore and Stroke	Cyl.	Disp	Carb.	Ignition	Plugs	No.	Pistons	Oil	Wheels	TIRES			W. B.
												Make	Front	Rear	
Peugeot	Resta	3.70x6.65	4	224.3	Miller	Bosch	KLG	8	Levett	Oilzum	R.W.	Silvertown	34x4½	35x5	106
Mercedes	DePalma	3.70x6.49	4	178.0	Mercedes	Bosch	Rajah	8	Levett	Monogram	R.W.	Silvertown	32x4½	33x5	112
Sunbeam	Christiaens	3.21x6.14	6	299.8	Miller	Bosch	KLG	6	Levett	Castorol	R.W.	Silvertown	35x5	35x5	106
Duesenberg	O'Donnell	3.75x6.75	4	298.2	Miller	Bosch	Rajah	8	Levett	Oilzum	R.W.	Silvertown	32x4½	33x5	106
Sunbeam	Galvin	3.21x6.14	6	299.8	Miller	Bosch	Rajah	6	Levett	Castorol	R.W.	Silvertown	35x5	35x5	106
Hudson	Vail	3.50x5.00	6	288.6	Hudson	Delco	Rajah	6	C.I	Veedol	R.W.	Silvertown	34x4½	35x5	105
Duesenberg	D'Alene	3.75x6.75	4	298.2	Miller	Bosch	Rajah	8	Levett	Oilzum	R.W.	Silvertown	33x4½	33x4½	106
Burman	Gable	3.63x7.93	4	279.8	Miller	Bosch	KLG	4	Alloynaem.	Castorol	R.W.	Silvertown	33x4½	34x4½	104
Hudson	McCarthy	3.75x6.75	6	288.7	Hudson	Delco	Rajah	6	C.I	Castorol	R.W.	Silvertown	33x4½	33x4½	102
Crawford	Lewis	3.75x6.75	4	298.0	Miller	Bosch	Rajah	8	Levett	Oilzum	R.W.	Nassau	32x4	34x4½	106
Duesenberg	Buzanne	3.98x6.00	4	300.0	Miller	Bosch	Rajah	8	Levett	Oilzum	R.W.	Silvertown	32x4½	33x5	106
Peugeot	Rickenbacher	3.74x6.65	4	292.6	Miller	Bosch	Rajah	4	Levett	Castorol	R.W.	Silvertown	34x4½	35x5	106
Delage	Oldfield	3.74x6.29	4	275.0	Miller	Bosch	Rajah	4	Alloynaem.	Oilzum	R.W.	Firestone	34x4½	35x5	104
Kline Sp.	Alley	3.98x6.00	4	300.0	Miller	Bosch	Rajah	8	Levett	Monogram	R.W.	Silvertown	32x4½	33x5	102
Kline Sp.	Kline	3.98x6.00	4	300.0	Miller	Bosch	Rajah	8	Levett	Monogram	R.W.	Silvertown	33x4½	33x4½	106
Ogren	Henning	3.98x6.00	4	300.0	Miller	Bosch	Rajah	8	Levett	Castorol	Houk	Nassau	33x4½	34x5	106
Crawford	Johnson	3.75x6.75	4	298.2	Miller	Bosch	Rajah	8	Levett	Castorol	R.W.	Nassau	32x4½	32x4½	106
Osteweg	Haibe	4.34x5.00	4	296.0	Miller	Bosch	Answer	8	Levett	Oilzum	Houk	Silvertown	32x4½	33x5	102
Olsen	Thompson	3.50x5.00	4	192.4	Miller	Bosch	Rajah	8	Levett	Sexton	R.W.	Silvertown	32x4	33x4½	108
J.J.R.	Watson	3.75x6.75	4	298.2	H & N	Bosch	Rajah	8	Levett	Oilzum	R.W.	Silvertown	33x4½	33x4½	101
West Duluth	Rawlings	3.75x6.75	4	298.2	Miller	Bosch	Rajah	8	Levett	Castor-Sexton	R.W.	Silvertown	33x4½	33x4½	106

All cars equipped with Boyce Motometers except D'Alene's Duesenberg and Rawlings' West Duluth. All cars equipped with Hartford shock absorbers except DePalma's Mercedes.

Stops at the Pits in Chicago Race

Peugeot—Rickenbacher.

122 miles. Out. Broken valve.

Burman Sp.—Gable. Five stops.

2:46 p. m., 30 sec. Changed right rear.
3:07 p. m., 1 min. Changed right rear and took gas.
4:23 p. m., 1 min. 15 sec. Took on gas and oil.
4:27 p. m., 34 sec. Tightened right rear wheel nut.
5:10 p. m., 18 sec. Took on gas.

Olsen—Olsen. Six stops.

2:41 p. m., 34 sec. Consultation.
2:58 p. m., 1 min. 17 sec. Tightened hood strap. Consultation.
3:13 p. m., 2 min. 59 sec. Adjusted carbureter.
3:59 p. m., 1 min. 41 sec. Took on gas.
4:54 p. m., 3 min. 30 sec. Changed drivers. McBride at wheel. Changed right front tire.
5:11 p. m. Out. Broken connecting-rod.

Duesenberg—O'Donnell. Five stops.

2:58 p. m., 1 min. Changed right front tire.
3:10 p. m., 35 sec. Changed right rear tire.
3:38 p. m., 1 min. Took on oil, adjusted motor.
4:16 p. m., 1 min. Changed right rear tire; took on oil.
4:44 p. m., 1 min. Changed right rear tire; examined gas supply.

Osteweg Sp.—Haibe. Seven stops.

3:08 p. m., 1 min. 32 sec. Oiled stuck valve stem.
3:17 p. m., 1 min. 42 sec. Oiled stuck valve stems.
3:30 p. m., 3 min. 2 sec. Oiled stuck valve stems.
3:39 p. m., 4 min. 35 sec. Adjusted carbureter. Oiled valve stems.
3:48 p. m., 4 min. 35 sec. Oiled stuck valve stems.
4:13 p. m., 14 min. 22 sec. Oiled valve stems; changed plugs.
4:33 p. m. Out. Valve trouble.

Crawford—Johnson. Five stops.

2:22 p. m., 48 sec. Changed plug.
2:48 p. m., 33 sec. Changed left rear tire.
3:24 p. m., 5 min. 30 sec. Changed spark plugs.
4:05 p. m., 25 sec. Changed left rear tire.
5:13 p. m., 32 sec. Took on gasoline.

Hudson Sp.—McCarthy. Three stops.

3:06 p. m., 42 sec. Changed right rear tire, took on gas.
3:23 p. m., 42 sec. Changed left rear tire.
5:17 p. m., 38 sec. Changed right rear tire.

Duesenberg—Buzanne. Five stops.

3:34 p. m., 3 min. 22 sec. Tightened water pump packing nut; took on water and oil.
3:54 p. m., 3 min. 10 sec. Changed plugs and repaired leaking pump gland.
4:37 p. m., 3 min. 34 sec. Took on water and oil; repaired leaking pump gland.
5:16 p. m., 2 min. 10 sec. Changed spark plugs.
5:39 p. m., 1 min. 7 sec. Took on water; changed plug.

Sunbeam—Galvin. Two stops.

4:01 p. m., 1 min. 4 sec. Took on gas.
4:32 p. m., 24 sec. Changed right rear tire.

Duluth Sp.—Rawlings.

3:18 p. m. Out. Broken connecting-rod.

Duesenberg—D'Alene. Three stops.

3:19 p. m., 22 sec. Changed right rear tire.
3:41 p. m., 2 min. Tightened nut on steering knuckle.
4:57 p. m., 1 min. Adjusted carbureter.

J. J. R.—Watson. Three stops.

3:27 p. m., 38 sec. Changed right rear tire.
3:56 p. m., 1 min. 11 sec. Took on gas; consultation.
4:15 p. m. Out. Broken connecting-rod.

Peugeot—Resta. One stop.

3:27 p. m., 2 min. Changed right rear tire; took on water and gas.

Mercedes—De Palma. Two stops.

3:22 p. m., 59 sec. Left rear tire and oil.
5:14 p. m., 1 min. 4 sec. Changed spark plug.

Kline Sp.—Alley.

2:23 p. m. Ruled out by officials for smoking.

Hudson—Vail. One stop.

3:41 p. m., 36 sec. Changed left rear tire.

Kline Sp.—Kline. One stop.

3:11 p. m., 2 min. 59 sec. Took on water, oil and gas; adjusted carbureter.

Crawford—Lewis. Five stops.

2:20 p. m., 25 sec. Changed right front tire.
2:45 p. m., 1 min. 33 sec. Changed right rear tire; consultation.
3:25 p. m., 34 sec. Changed right rear tire.
4:28 p. m., 1 min. 18 sec. Changed left rear tire; took on gas and oil.
5:15 p. m., 2 min. 25 sec. Took on water and oil.

Ogren—Henning. Eight stops.

2:31 p. m., 40 sec. Changed right rear tire.
2:43 p. m., 40 sec. Changed left rear tire.
2:49 p. m., 2 min. 30 sec. Changed right front tire; consultation.
3:13 p. m., 50 sec. Changed right rear tire.
3:36 p. m., 1 min. 22 sec. Changed right rear tire.
4:06 p. m., 5 min. Repacked water pump; took on water.
4:31 p. m., 9 min. Wires broken water pump bracket in place; took water.
4:58 p. m., 4 min. 3 sec. Repacked water pump gland; changed left rear tire.

Sunbeam—Christiaens. One stop.

3:47 p. m., 35 sec. Took on gas.

Delage—Oldfield.

2:25 p. m. Out; broken transmission.

A Study of High-Speed Engines

Reviewing the Reasons for Their Existence and Analyzing Several Important Problems of Their Design Including Lubrication and the Elimination of Balancing

By A. P. Brush
Consulting Engineer

THIS paper is a review of the reasons for the existence of high-speed engines and touches upon several of the problems in connection with their design, notably lubrication and the elimination of balancing. The author's analysis of the reasons which have brought the high speed engine into prominence are very interesting and admit of small debate, and his championing of the interconnected throttle and oil supply is also a matter with which few can disagree. The portion of the paper reprinted herewith deals with the problems of crankshaft balance, and is about as clear an explanation as could be devised. The paper follows:

We now come to a phase of engine design the effect of which increases as the square of the engine speed. In any rotating mass three kinds of balance are involved. For comparison and analysis I shall call them static balance, running clear an explanation as could be devised. The paper follows:

Static balance is secured whenever the axis of a rotatable mass passes through its center of mass, but such a mass need not necessarily be in either running or distortion balance.

Any mass in either running or distortion balance must however be in static balance; that is, running balance and distortion balance are each a special condition or form of static balance.

Running balance can be described as that condition or form of static balance in which any centrifugal couples are equal and opposed, and therefore neutralize each other.

Distortion balance can be described as that condition or form of *static and running balance* in which all centrifugal forces within any plane at right angles to the axis (that is, within any plane of rotation) are balanced.

For purposes of illustration and analysis, let us consider the diagrams of rotatable masses, Figs. 1, 2 and 3, in which A represents the axis, M any specified mass, R any specified distance between M and the axis, and C the center of mass of the system.

In Fig. 1 we have a case of static balance, inasmuch as A passes through C, but we have not running balance, since M and M' upon rotation about A will form an unneutralized centrifugal couple tending to force A out of position.

In Fig. 2 we have a condition of static balance (inasmuch as A passes through C) that is also running balance; that is the centrifugal couple between M and M' is equal and opposed to the centrifugal couple between M'' and M''', and there is no tendency to displace A as a whole. Fig. 2 does not, however, represent a condition of distortion balance, as the opposed centrifugal couples tend to bend the axis A.

If, however, our masses be arranged as in Fig. 3, so that M' and M lie in the same plane of rotation as do also M'' and M''', we have the special form or condition of static balance (inasmuch as A passes through C) that also represents running and distortion balance.

Balance in Four- and Six-Throw Crankshafts

As applied to conventional four- and six-throw crankshafts, static and running balance are, or should be, always achieved within the limits of workmanship.

For reasons I shall point out later, a single-throw crankshaft, for best results in service, should not be in either static or running balance; a two-throw crankshaft with the throws opposed, for best results in service, should be in static, but not in running balance.

It is only within the present period of high-speed engine developments that the importance of distortion balance, so nearly as it can be achieved in a crankshaft, has begun to be understood. Inasmuch as its functions exercise a certain control over the form of a crankshaft, what is commonly known as counterbalancing is required to bring any crankshaft into any condition of static balance.

Running balance in conventional four- and six-throw crankshafts, by means of counterbalancing, can readily be and, as I have said, is almost universally secured. Distortion balance in a crankshaft can never be absolute, because of the effect of its functions upon its form. The closest possible approximation to distortion balance that can be secured in any crankshaft was commonly known and used before the advent of the automobile.

Irreducible Minimum Distortion Couple

Fig. 4 represents a single-throw crankshaft in which M and M' are counterweights, having a common centrifugal effect equal to the centrifugal effect of the crank-cheeks and -pin. There is obviously a slight distortion tendency here, due to the fact that the pin mass lies between the counterweights M and M', with a slight resultant tendency to bend the crankpin. This approximation of distortion balance in a crankshaft can be properly described as the irreducible minimum or single-throw distortion couple, and will be recognized by all of you as ancient mechanical practice.

I shall hereafter refer to a crankshaft which has a single-throw distortion couple, as being in complete distortion balance. Of course no condition of static balance can be achieved in a single-throw crankshaft without resorting to the addition of counterbalancing masses, as represented in Fig. 4. In Fig. 5 however (representing a single-plane two-throw crankshaft) we find a condition of static balance (not of running balance) apparently without the use of counterbalancing. The counterbalancing exists, inasmuch as each throw acts as a counterbalance for the other. This is also true in Fig. 6, which represents the conventional three-bearing four-throw four-cylinder crankshaft. In Fig. 6 however (which like Fig. 5 is automatically counterbalanced without the addition of extra counterbalancing masses) we have a natural condition of running balance, but not complete distortion balance, and the center bearing is required to help resist the bending tendency due to the lack of distortion balance. This load on the center bearing, while negligible in low-speed engines, is by no means negligible in the modern high-speed engines, and it is not unusual to see counterbalancing masses added to shafts of this type as in Fig. 7 to bring them to complete distortion balance.

Two-Bearing Four-Cylinder Crankshafts

In small-bore high-speed engines the lack of distortion balance causes much greater load upon the center bearing than

Illustrating Various Phases of Crankshaft Balance in High-Speed Engines

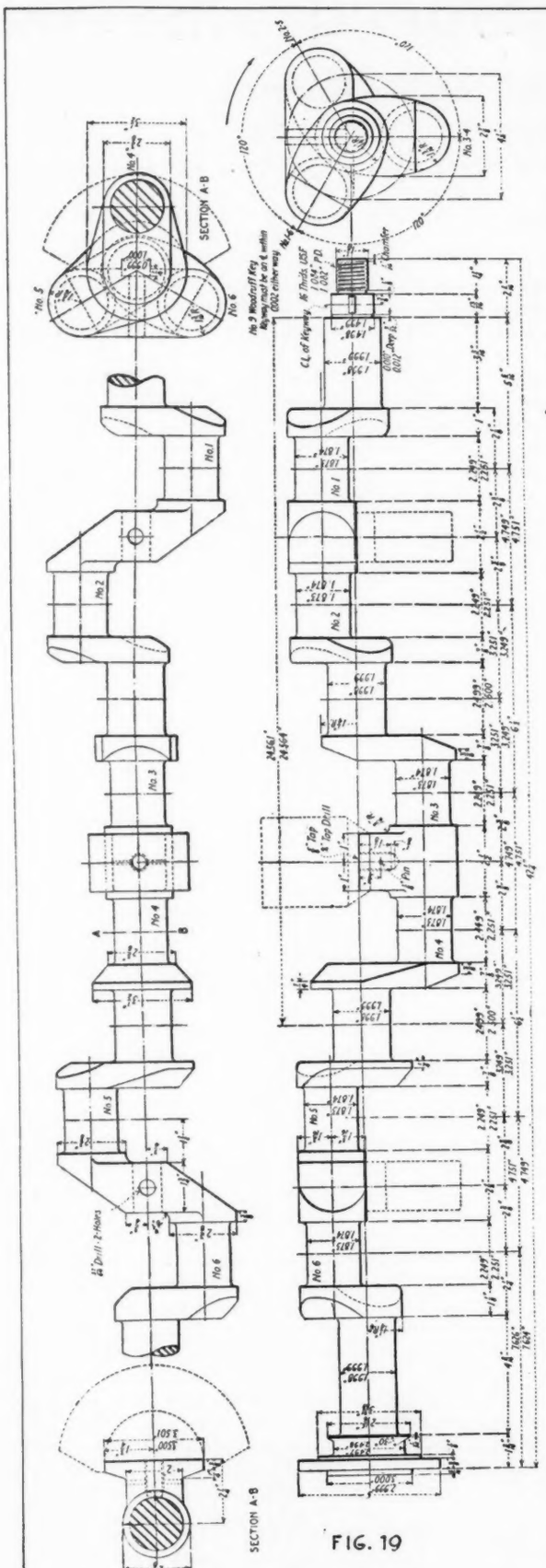


FIG. 19

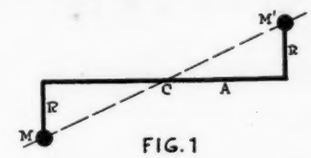


FIG. 1

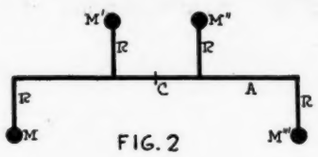


FIG. 2

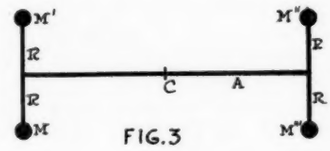


FIG. 3

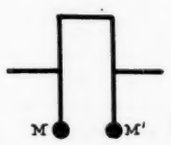


FIG. 4

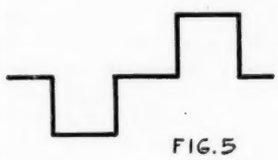


FIG. 5

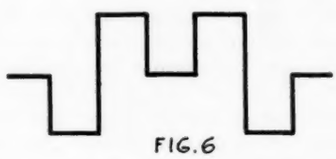


FIG. 6

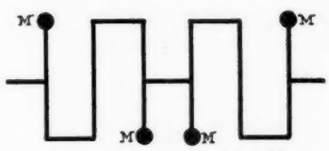


FIG. 7

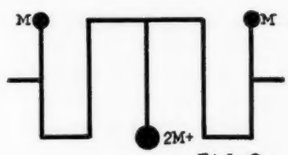


FIG. 8

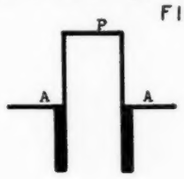
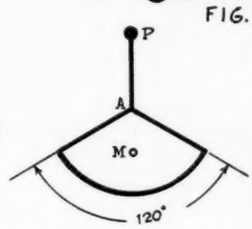


FIG. 9



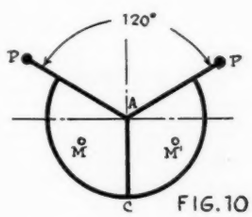


FIG. 10

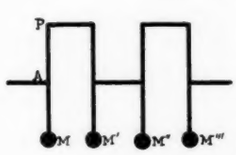


FIG. 11

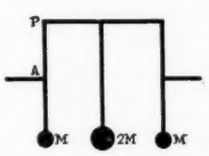


FIG. 12

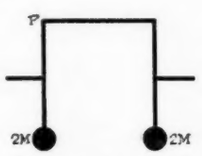


FIG. 13

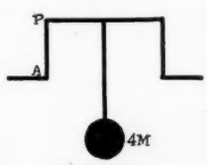


FIG. 14

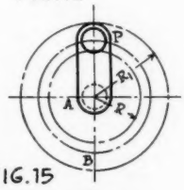


FIG. 15

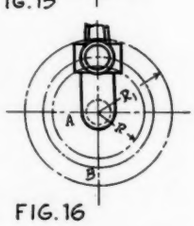


FIG. 16

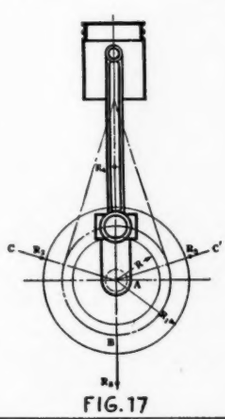


FIG. 17

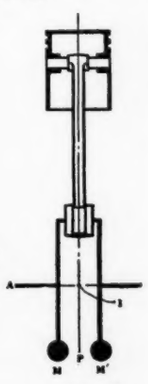


FIG. 18

does the explosion pressure in the cylinders. This fact accounts for some of the troubles encountered in two-bearing four-cylinder crankshafts. Two-bearing four-cylinder crankshafts for small-bore high-speed engines are entirely feasible, provided counterbalancing masses are added to the crankshaft as indicated diagrammatically in Fig. 8. In this figure the value given for the center counterbalancing mass is $2M+$, since the center crankpin carrying two connecting-rods is always longer than the two end pins. This difference in length and weight should be considered in determining the centrifugal value of the center counterbalancing mass.

In both Figs. 7 and 8 the distortion couple is reduced to the minimum of a single throw, although a counterbalancing mass is added only at one side of each throw. A counterbalancing mass might be added at each side of each throw, as shown in Fig. 4, but inasmuch as the crankshafts so far considered are all single-plane crankshafts (that is crankshafts in which the axes of all crankpins and the axis of the crankshaft lie in a single plane) the mathematical merging of two counterbalancing masses, opposed and in the same plane of rotation, results in a cancellation of their centrifugal forces and therefore *permits* the elimination of such masses. So far as the single-plane crankshaft is concerned, the securing of complete triple balance (that is, static and running balance with distortion couples reduced to the irreducible minimum of a single throw) is mathematically identical with the counterbalancing of a single-throw crankshaft.

Six- and Twelve-Cylinder Crankshafts

Let us now consider the three-plane crankshaft as used in modern six- and twelve-cylinder automobile engines. Fig. 9 shows a side and end view of a counterbalanced single-throw crankshaft, in which, as is obviously possible, the applied counterbalancing mass has a contour such that the included angle between its sides when viewed from the end is 120 deg., P representing the center of crankpin, A the axis of the crankshaft, and M the center of mass of the counterweight. If six of these throws are formed into one shaft with a bearing on each side of each throw, we can obviously have a conventional seven-bearing six- or twelve-cylinder crankshaft in complete triple balance.

If we omit a bearing between any two throws, one cheek and one counterbalance of each of these throws will lie in the same plane, as illustrated in the end view in Fig. 10. In this type of shaft the angle between each pair of adjacent crankpins, except the two center ones, is 120 deg. As in Fig. 9, P represents the center of the pin, A the axis of the shaft, and M and M' the centers of mass of the counterweights. Inasmuch as the specified included angle between the sides of each counterweight is 120 deg., these two counterweights when brought into the same plane by the elimination of an intermediate bearing, will have their adjacent edges in contact as shown along the line C. This means that the two counterweights can be merged into one having an included angle between the sides equal to the sum of the included angles of both weights, with the common center of mass lying in the line of union C of their adjacent sides, and having a mass equal to the sum of the two counterweights. Any form of counterweight can be used whose center of mass lies in this same line (C in Fig. 10), the centrifugal value of which is the same as the combined counterweights shown. For obvious mechanical reasons it will always be desirable to adopt a counterweight form with an included angle of less than 240 deg. between its sides, but the adoption of such a different form of counterweight in no way alters the mathematical fact that it is and must be the exact centrifugal equivalent of the two combined counterweights, as illustrated in Fig. 10.

Six-Throw Shaft with Two Center Throws

Now let us consider the special case of the two center throws in the conventional three-plane six-throw crankshaft. Fig. 11 shows these two center throws in the seven-bearing form of this type of crankshaft (that is, with a bearing on each side of each throw), in which A represents the axis of the crankshaft, P the center line of the pins, and M, M', M'' and M''' the counterbalancing masses. If, as in the four-bearing conventional three-plane six-throw crankshaft, the center bearing be omitted, this central portion of the shaft takes the form illustrated in Fig. 12, in which case complete triple balance can be secured for these two center throws with three counterbalancing masses instead of four, the center counterbalancing mass of the three obviously having a value of $2M$. An expedient that secures a close approximation to distortion balance is shown in Fig. 13, in which only two counterbalancing masses are required, each having the value of $2M$. In this case the distortion couple is two throws long and therefore not the minimum, but is a sufficiently close approximation for all practical purposes.

Fig. 14 shows a still further simplification (which has been used) of securing approximate triple balance of the two coincident center throws of a four-bearing three-plane six-throw crankshaft, in which these two center crankpins are counterbalanced by the use of a single counterbalancing mass, having a value of $4M$. The conventional four-bearing three-plane six-throw crankshaft in Fig. 19 was designed under the writer's supervision early in 1912. Approximate triple balance was secured by merging the three center counterbalancing masses in Fig. 12 into one, as shown in Fig. 14, and also by a mathematical merging of the three counterbalancing masses, theoretically necessary for each of the two end throws, into two counterbalancing masses as shown in Fig. 19.

To secure what I have described as complete triple balance in conventional three-plane six-throw crankshafts, the seven-bearing type requires twelve counterbalancing masses, and the four-bearing type obviously requires nine counterbalancing masses, in which case each of two of these masses is the centrifugal equivalent of two 120-deg. merged weights, and one of them is a coincident merged weight as in Fig. 12, the others being simply single-throw counterbalancing masses. The four-bearing crankshaft can however, as I have already pointed out, be in complete triple balance, except the center throws, with eight weights.

The conventional three-bearing three-plane six-throw crankshaft is in some ways the simplest crankshaft of this type in which to secure what I have described as complete triple balance. In this case only eight weights are required; that is, four single-throw weights on the cheeks adjacent to ends of the center line bearings and four 120-deg. merged weights on each of the four merged crankthrow arms where center line bearings are omitted.

Single-Throw Shaft Basis of Balancing

From the foregoing description of the fundamentals of crankshaft counterbalancing it becomes apparent that the science of counterbalancing a crankshaft of any number of throws, or of any form, is only the science of counterbalancing a single-throw crankshaft, inasmuch as the mathematical merging of two counterbalancing masses lying in the same plane of rotation, is an obvious mechanical expedient. Bearing this in mind, it is evident that we can examine the whole science of crankshaft counterbalancing by an analysis of correct counterbalanced values for a single-throw crank. In the remainder of this discussion of crankshaft counterbalancing, I shall therefore confine myself to consideration of the single-throw form of crankshaft.

We have so far considered the counterbalancing problem as regards the crankshaft itself. This is not sufficient, however, if counterbalancing is to achieve the desired result of minimizing pressure on the center line crankshaft bearings due to tendencies to distort under service conditions, espe-

(*Continued on page* 1100)

Self-Tensing Springs for Varying Loads Compared with Adjustable

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With Special Reference to the North Cantilever Spring with Adjustable Fulcrum

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By Marius C. Krarup

LARGE variations of speed cause auxiliary devices to play a prominent part in the spring equipment for speedy vehicles, while adjustment of spring flexibility is constantly contemplated as an obvious improvement for vehicles whose loads vary greatly. The best ultimate value of cantilever springs may perhaps be found in the readiness with which they lend themselves to adjustment by varying the location of their fulcrums and to an effective combination with auxiliary devices at their free ends. These considerations form in themselves a very large subject, which is mentioned here only to bring into proper perspective the relatively small and limited question as to whether it is preferable to adjust a spring in advance to load and speed variations or to have the variations of load, as they occur, automatically result in different rates of flexibility. There could be no doubt of the automatic arrangement being preferable, if it were demonstrated that the adjustments effected in this manner may be closely in accordance with the most important or average requirements.

The North cantilever spring with adjustable fulcrum, which was described in THE AUTOMOBILE of June 1 represents, on the other hand, the conviction that adjustment by hand produces results which are sufficiently superior to warrant the adoption of the system where adjustments are not so frequently required as, for example, for trucks and omnibuses. The claim for superiority over automatic adjustment is based on the fact that, in case of road shock, the rate of flexibility of the North spring remains the same throughout the deflection caused by the shock while the "compound" spring, being *"incapable of distinguishing, in its mode of action, between the deflection caused by a change of load and that caused by* a *brickbat lying in the road,"* shortens the deflection by its increasing rate of stiffness and at the same time aggravates the rebound by its increasing flexibility at the lower end of the spring stroke. There is added also the claim that in practice "compound" springs have never been found as comfortable as ordinary springs working with the normal load for which they have been designed, but this claim is of very narrow scope and is also, of course, not conclusive in itself, so long as "compound" springs have only been tried in a few variations of design and without suitable provisions for reducing rebound. In comparing the two types it should probably also be kept in mind that adjustment by hand for any contemplated condition of operation is more practical for European conditions than for the rough streets and roads in the United States, where one must always be prepared to cope with the unexpected.

Spring Range with Heavy Loads

In justice to the North system a considerable advantage should be mentioned to which no reference is made in the previous account of it taken from *The Automobile Engineer*. The distance between axle and vehicle frame can remain approximately the same at different adjustments of the springs, so that the range of action with a heavy load is not materially reduced, and no special provisions need to be made in the design of the vehicle for more than ordinary range of action. If a minimum load of 800 pounds produces, for example, an initial deflection of 4 inches at a flexibility rate of 1 inch per 200 pounds, and the maximum load is 600 pounds more, to which corresponds an adjustment giving an 80 per cent decrease of flexibility, which makes the rate 1 inch per 350 pounds, the total load on the spring of 1400 pounds supported at this rate produces again a deflection of 4 inches. It is learned that the designer, the late Mr. North, was strongly conscious of this advantage.

To be compared with the North system the automatic system must be viewed in its possibilities, rather than with reference to any form actually placed in the market, as the need of special construction or special auxiliary devices for use in conjunction with it has not been widely realized. To get away from the ambiguous terms "compound"' or "progressive," which do not describe this system well, it is suggested that "self-tensing" springs might be adopted as a term designating springs whose rate of flexibility is decreased automatically to suit (though not necessarily in exact proportion to) the load they carry at any given moment; this leaving the question open as to whether it is a necessary feature—as claimed in favor of the North system—that the deflection caused by a jolt shall have exactly the same effect as the much slower action of a load change.

"Self-Tensing" Springs

As examples of simple self-tensing springs there may be mentioned: The coil spring with coils of varying diameter, which becomes self-tensing when the most flexible coils begin to collapse; the elliptic spring so curved that active length shortens by deflection; the cantilever spring whose free end shortens by deflection, as by automatic change of fulcrum.

Strong Rebound and Other Objections

Beginning with the most serious objection raised against self-tensing springs, to wit, excessive rebound, it may first be mentioned that the need of rebound checks for all springs, and of course especially for rough roads, is becoming more and more widely recognized, and that the need of special rebound checks or shock absorbers in conjunction with self-tensing springs is therefore not a strong objection, provided they accomplish what is necessary in order to remove the principal objection to self-tensing springs under all circumstances of service. The other objection, relating to shortened deflection for a shock of given force, may be met by a higher rate of flexibility throughout the normal range of spring action in vehicles whose design admits of increased total range of spring action, while for other vehicles the objection must probably hold good. Too high initial camber of leaf springs and reduced spring range for heavy loads constitute other objections which must be taken up.

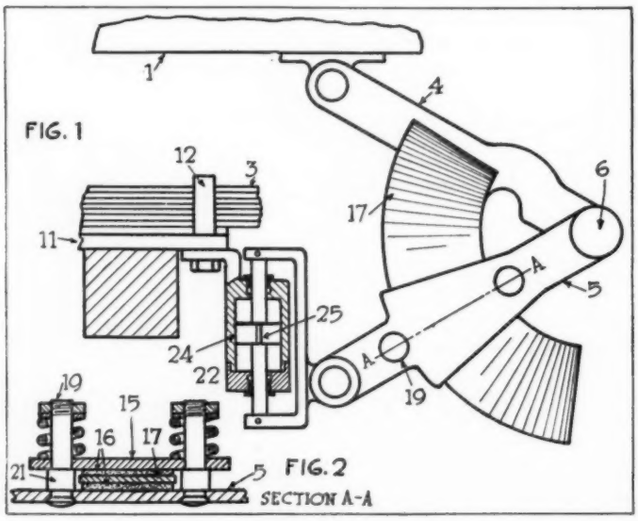
With regard to the means for escaping excessive rebound, attention may be called to two devices which can be used for limiting rebound with close reference to the position from which the spring action starts when a jolt is received, this position varying with the load, of course. The first device is patented by Loomis and assigned to the Packard Motor Car Company. The principle is shown in Figs. 1 and 2. (In

another form of it, which is equivalent in principle, the appearance is improved by having the sluggish element operated by rotation around the free pivotal joint, 6, of the arms instead of by dashpot). Plate 17 is supposed to be secured to arm 4 and is thinnest at the middle where it is loosely grasped between friction linings 16 of arm 5 and plate 15, these being held in elastic mutual relations by pins 19 and coil springs 18, as shown separately in Fig. 2. The shape of plate 17 is determined by the rate at which it is desired that the friction of the device shall be increased when arm 5 is moved toward arm 4, by deflection of vehicle spring 3, or away from it, by rebound beyond the position of equilibrium represented in Fig. 1.

Arm 4 is pivoted to vehicle frame 1, and arm 5 to a bracket secured, as shown, to piston 24 in dashpot 22, the latter secured to spring pad 11 of axle 2 by clip 12. The dashpot is filled with a very thick fluid, such as graphite grease, and a small aperture 25 in piston 24 admits of a very slow relative movement between the piston and the dashpot.

When a shock is received on the road, arm 5 will be actuated from piston 24 as if the latter were securely attached to the axle, the duration of the shock being too short to get the dashpot into action. The device will therefore work in accordance with the plan followed in the shaping of plate 17. This would not be the case after changing the load of the vehicle, except for the compensating effect of the dashpot feature. If the load were increased, arm 5 would be moved toward arm 4 with the vehicle at rest, and, on receipt of a shock the friction acting against deflection would be greater than for a lighter load, while the friction restraining the rebound would be reduced. With the dashpot in action, an increase of load moves arm 5 toward arm 4, but the first few shocks afterward received move the piston, by means of the resistance encountered, down to the position which again brings arm 5 to grasp the thinnest portion of plate 17 when the vehicle is at rest, and the whole action of the device thereby becomes the same as it was before the load was increased.

If it is assumed that the thickness of the substance in the dashpot, the dimensions of aperture 25 and the shape of plate 17 are factors which can be brought into harmony with each other, it becomes evident that the device will have two effects which are of interest in this connection. First, the upper portion of plate 17 will act by reason of its shape as self-tensing auxiliary against shocks (but will not help the vehicle spring to sustain increased load, as a true self-tensing spring does), and, as the friction on the return of arm 5 to neutral practically equals the friction operating against deflection, the force of the rebound will not be as great as



Figs. 1 and 2—Packard company's patented shock absorber with compensation for variations of the vehicle load

that which would be experienced with the vehicle spring unassisted and subject to a larger deflection from any given shock. Secondly, the lower portion of plate 17 can evidently be shaped so as to limit the rebound, below the neutral position, with any desired gradation or abruptness. The device is therefore an example, in conjunction with an ordinary vehicle spring, of an arrangement producing a self-tensing effect by means of friction, having automatic adjustment to load changes and involving no increase of rebound but, on the contrary, any desired checking of the rebound. Plate 17 can be shaped so as to leave the vehicle spring almost free of restraint for all small shocks, for which purpose the enlargements 21 on pins 19, Fig. 2, serve to space arm 5 and plate 15 apart. The principal theoretical shortcoming in comparison with the North system of adjustment by hand lies in the reduced range of action with heavy loads which the arrangement has in common with the use of ordinary springs alone if these are made flexible enough for light loads; and this shortcoming applies only to pleasure cars and omnibuses where the range of action is limited by a certain scant maximum distance between frame or body parts and axle parts.

Probably there are practical difficulties in the construction, such as in making the automatic adjustment operate reliably, in making friction elements conform to the best shape of plate 17, and in the method of checking the rebound by a friction which at first diminishes as the spring returns toward the neutral position, but the patent was applied for in 1908 and does not in these features represent the best that may be done to-day.

Another Rebound Check for Varying Loads

The other device showing that self-tensing springs may be combined with complete checking of the rebound irrespective of the load carried was designed by the writer for use with any type of spring suspension and is illustrated in Fig. 3, giving two sectional views. It can be operated with glycerine, oil or grease of any preferred consistency, this feature affecting only the adjustment and the size of the vent in the free piston 7, but as the degree of consistency or fluidity should not be affected much by the temperature of the atmosphere, a thin oil with or without graphite admixture is probably best. The base 1 is secured to the vehicle frame and the wing piston 2 is keyed to the annular central boss of the outer cover plate 3, which is connected by the usual jointed arm to the vehicle axle, so as to be actuated when the vehicle springs are actuated. The interior cover plate 4 (with holes for pins 10, 13 and 14) is closely fitted into a recess in the outstanding flange of base 1 and a corrugated copper ring 5 protects against leakage at the joint between the two cover plates. Stop 6 limits the downward movement of free piston 7. Nut 8 with washer holds the outer cover plate in alignment and may be secured by locknut arrangement. The one-way valve flap 9 on pin 10 in conjunction with plug 11 constitute the adjustment by which the whole rebound stroke can be moderated at any desired rate. Hollow plug 12 normally contains only air and provides for irregularities in the expansion or contraction of materials and fluid.

Damping Rebound Stroke Only

Deflection of the vehicle spring turns wing piston 2 downward, and the fluid driven before it raises free piston 7 a corresponding angle, the vent being so small as to have no appreciable effect in the case of a rapid spring movement. The fluid in the upper part of its circular path opens the one-way valve 9, passing practically unhindered. When the rebound stroke begins and wing piston 2 starts back, valve 9 closes and fluid is forced through space above it, which can be restricted more or less by adjustment of plug 11. The rebound stroke is thus retarded from its beginning as much as desired. Meantime the free piston 7 is being driven back toward stop 6 and reaches it at

the same moment as wing-piston 2 reaches its starting position. Any further rebound movement of wing piston and vehicle spring must take place by forcing the fluid through the vent in free piston 7 and along its surfaces of contact in the device. The more the rebound is restricted from its start by the one-way valve 9 and plug 11, the less abrupt is the checking caused by free piston 7 and stop 6.

The action for load variations, which is the feature of interest for comparing the North system of spring adjustment with automatic self-tensing springs, is as simple as possible. If the load of the vehicle is increased, wing-piston 2 takes a new and lower neutral position, and free piston 7 is raised momentarily, but at once begins to gravitate back to the stop, the fluid passing slowly through the vent. Thereafter the action of the device is the same as it was with the lighter load, that is, spring rebound is again checked from its beginning, at a rate determined by the adjustment (which is constant for a given vehicle) and is finally checked at the moment when the vehicle spring reaches the position of equilibrium with its static load.

Similarly, if the load is reduced, the wing piston rises slowly to a new initial position, forcing the fluid through the vent in the free piston which remains at rest against stop 6. The action for shocks is thereafter again the same as before. The free piston is made sufficiently heavy to make its gravitation—producing the automatic adjustment to increased load—certain and definite, with the size of vent and the kind of fluid substance selected.

These two devices suffice to show that there are no great mechanical difficulties in removing North's principal objection to self-tensing springs; namely, that their strong rebound produces discomfort. The object of using self-tensing springs, being mainly to take equally good care of light and of heavy loads, which is also the object of the North cantilever spring with adjustable fulcrum, a simple device which takes care of the rebound in any desired degree independently of what the load is, becomes the first important element in favor of self-tensing springs for variable loads.

Camber and Spring Range

But other objections remain to be considered. It has been seen that, if the equivalent of self-tensing properties for shocks are produced by a friction device combined with ordinary springs, the deflection of the springs under loads will be strictly in proportion to their flexibility, and they must be either too stiff for light loads, or their original camber must be greater than desirable and the range of spring action will be reduced too much for the maximum load in the case of pleasure cars and omnibuses, in which the possible range is limited by the conventional vehicle design; and this objection will hold good even if the friction device operates with equal correctness for light and heavy loads. Also, the objection relating to the strong original camber of the spring leaves, holds good even for motor trucks having ample spring range as well as for pleasure cars.

With a true self-tensing spring that is load-supporting at all stages, these objections lose some of their force, as it always carries its load as high as an ordinary spring of the tension which would be chosen for a normal load corresponding to that momentarily carried by the self-tensing spring. But as a self-tensing spring should be considerably more flexible in its light-load range than an ordinary spring can be (being calculated for normal or maximum loads), the original camber of its leaves would necessarily be strong in order to have it come normal for light load, if it were not possible and practicable to make special provisions to avoid this objectionable feature.

Cross Springs for Minimum Load

Such a provision, and one of the most plausible schemes in this connection, is to use for the static support of the minimum load either an elliptic spring crosswise of the vehicle between axle and frame—as may be most suitable for trucks—or a semi-elliptic (perhaps two quarter-elliptics instead) secured at its middle to a frame transverse and at its ends shackled to the axle or to the rear of the brake beam, and to have this cross spring highly flexible. Evidently coil springs or air springs could be used similarly to hold the minimum load at the proper height—the height giving the needed spring range—and could be made self-tensing for all or part of their work, but this possibility lies farther afield than the use of light-load leaf springs.

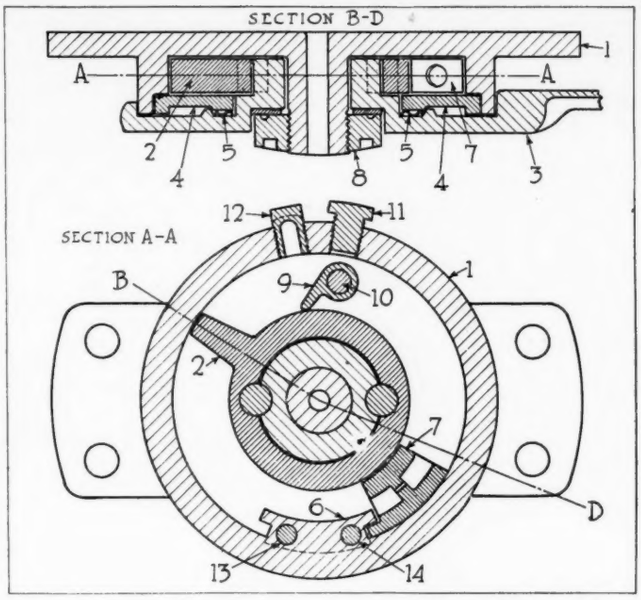


Fig. 3—Device for damping and checking rebound stroke correctly with any vehicle load

Self-tensing cantilever springs at the sides of the vehicle, used in conjunction with such highly flexible cross-springs for the static minimum load, could then be made straight, short and thin-leaved without getting bulky, having only to handle the difference between minimum and maximum loads plus their share of the jolts, and the frame support would be better distributed than with cantilever springs alone, while the lateral stability would also be better secured.

For pleasure cars a sufficient range of loads could no doubt be suitably sprung on this plan by having the cantilever springs alone self-tensing, while for trucks it might be better to arrange also the cross-spring on the self-tensing plan or to incorporate progressive friction in the rebound check or shock absorber, as in the Loomis device. Or, for pleasure cars, the cross-springs could be self-tensing and the cantilever springs normal.

One-Sided Loads

Comparing again with the North system, it is noted that the latter fails to compensate for one-sided load variations, which are especially important in omnibuses, while the plan mentioned differentiates properly between the heavy and the light side of the vehicle.

It should perhaps also be noted that, with the rebound check preventing all spring action below static equilibrium, the stability could not suffer, even when driving with a light load supported on the highly flexible cross-springs alone.

To finish the comparison with the North system (or, more broadly, with the plan of adjusting vehicle springs to a load variation by advance operation of an adjustment device) it should be shown in detail how a cantilever spring may be arranged to act on the self-tensing plan, and how other types of spring may be so arranged, but the purpose is here only to show that, in general, the self-tensing plan seems better worth developing than the plan of operative adjustment.

It seems incontestable, however, that the North system after all retains one advantage: With reference to pleasure cars, it makes a simpler provision for sufficient range of spring action at all adjustments than any which it has so far been shown can be incorporated in the self-tensing system, if the latter shall give an equally ample deflection for a given shock at maximum load. But a number of possibilities remain for overcoming also this superiority. A step in this direction would be taken, for example, if a shock absorber (with rebound check) could be devised in which the friction, or other form of resistance, would be increased by an increase of the vehicle load but would remain constant during a deflection caused by a jolt.

In the whole subject, the use of dampers and rebound checks which are self-adjusting to load variations, and the use of separate minimum load springs of high flexibility, seem to the writer to be the leading ideas, which in the end should make self-tensing springs wholly practicable.

Paragraphs on Current Topics

By Marius C. Krarup

Motto: Radical Thought, Conservative Action

"Those who think that speed is the great cause of street accidents might do worse than consider the possibility of establishing their case by facts instead of relying upon vague enunciations," writes Francis M. Hugo, Secretary of New York State, and recommends "a critical scrutiny of the evidence given and verdicts returned at each of the hundreds of coroner's inquests held on victims last year." Such a scrutiny "ought to show how far the accidents were reasonably attributable to the speed at which the vehicles concerned were traveling." It might also show certain insufficiencies in the average coroner's inquest which would react upon the reasoning and leave us in the same uncertainty as before.

□□□□

Motor of Copenhagen writes that the radical Jacobsen design, which was described and illustrated recently in this journal, is now being built into a Benz racing car in Germany, and that the inventor is also negotiating with the Mercedes branch of the German Daimler company.

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The American Automobile Association, better known as A. A. A., plans to have a national Good Roads Convention held every year at Washington under the direction of the Federal government, and more particularly under the auspices of the United States Office of Public Roads and Rural Engineering in the Department of Agriculture. In this manner somebody may eventually rise to tell the world how the Good Road is built which shall finally convince taxpayers that it is worth paying for, and therefore worth building and maintaining on a large scale.

□□□□

"No machine made by man could penetrate into the roadless mountains or follow the troopers over their almost impassable trails," sings an editor in dithyrambic enthusiasm over the army mule. Give two inventors and a dozen engineers financial *carte blanche* and a modest reward at the goal, and the impossible machine will be produced in six months and will not only penetrate but will pull a good many troopers with it and shelter them against bullets from ambush besides.

□□□□

The *Motor World* of Melbourne, Australia (issue of April 28, 1916, being Vol. II, No. 12), gives over a few practical pages to "Woman and the Car," almost entirely devoid of millinery and dress goods display. "Chauffing" as a vocation for women is proclaimed, in accordance with recent British example, as patriotic and in line with improved national efficiency—the work being done well enough by the women and the men released for more exacting occupations. From all sides American women are being crowded, by example of their sisters abroad, into the motor and automobile field.

□□□□

One of the smouldering questions in aviation—ready to burst into flame at any moment—is: "Are two motors safer than one?" Quite knotty, too, with weight and distribution of weight duly considered. We vote for one, at least until aeroplanes get very much bigger. But this recalls an interesting old theory. According to it, when aeroplanes become as big as a cloud it should be possible to keep them floating with scarcely any use of power, on the principle that they cannot fall without moving such quantities of air under them that the same, when forced to escape at the edges, would reach a speed so high as to set up resistance greater than needed for sustentation. This weird explanation of the heavy floating cloud must soon be due to come under discussion, as it unfolds several surprises applicable to aeroplanes (and to large flocks of birds) when looked into.

Library Service for Aid in Research

Referring to the article on this subject in last week's issue, W. P. Cutter, librarian and secretary of the Library Board of the United Engineering Society, 29 West Thirty-ninth Street, New York City, imparts the information "that just such a service"—as outlined in the article—"is offered here."

A circular inclosed with the letter explains this service and records requests for information from 239 localities in the United States during one year. During that period requests have also been received from 58 localities in 17 foreign countries. "Our chief difficulty is in publicity for this service," writes Mr. Cutter in conclusion.

A contribution to the desired publicity is hereby freely tendered; so much more readily as the writer has often made use of the excellent facilities of the United Engineering Society's library and yet has never been made aware that any special organization, such as the Library Service Bureau, to which Mr. Cutter refers, was, and is, in operation.

The circular explaining this service shows that its purposes are indeed similar to those which prompted the article last week. The methods adopted, on the other hand, differ materially from those suggested. Those interested can probably obtain the circular by writing for it.

Possibly next to a national library for preserving the originals of interesting illustrations—which, unlike words, suffer in reproduction—the nationalizing of library facilities for research would seem to be the most interesting subject connected with libraries in which the automobile industry and its engineers are concerned, and it may be entitled to be viewed from many angles.—M. C. K.

Boillot—Chevalier of the Legion

Dramatic Death of the Speed King of Europe

PARIS, June 3—About 6 o'clock on the morning of Saturday, May 20, Flight-Sub-Lieutenant Georges Boillot reported for duty to the officer in command of squadron No. 49, in the neighborhood of Verdun, and a few minutes later went aloft aboard his single-seater Nieuport 100 m.p.h. scout machine. On his uniform Boillot bore the red ribbon indicating that he was a Chevalier of the Legion d'Honneur, a decoration which had been awarded him a few days before in recognition of his bravery in aerial encounters. But he was not perfectly satisfied. Speed King of Europe, he was only one of hundreds of aviators, and far from best known. Opportunities had not presented themselves of showing that he could be as brilliant in the air as he had proved in many a fierce competition on the road.

GEORGES BOILLOT

As a scout pilot, Boillot's task was to keep away enemy machines, thus allowing the French observation planes, with a speed of only 60 m.p.h. and slow in their movements, to carry on their work of photographing and observing the effect of artillery fire without molestation. Away to the northeast beyond the outer-forts of Verdun, where French and Germans had been struggling day and night for 3 months, Boillot dimly observed the outlines of three enemy machines. The numbers increased to five—Albatross biplanes each with a couple of men aboard, and each armed with two machine guns. The Frenchman was alone with a single machine gun, at a height of 9000 ft., with only one feature in his favor: his Nieuport was faster and quicker on its controls than the German aeroplanes.

A Daring Attack

Most men would have dived for home or given the enemy an exhibition of speed until reinforcements had come up from below. Boillot's only idea was to attack. He had been waiting for such an opportunity for weeks. What really happened 9000 ft. above the battlefield on that beautiful May morning cannot be told, for the leading actor in the drama is no more. Speeding out to meet the invaders, Boillot tackled the leading machine before the others could come to its support, and sent it crashing down to the French lines. A few seconds later the observers saw the four remaining machines deploy for a converging attack on the swift French biplane. The machine guns got into action; their smoke was visible, but no sound could have been heard even had there been no artillery bombardment at the time. Suddenly Boillot's machine staggered, then dived, then capsized. A human form was seen to fall clear of it: the pilot was dropping earthwards a distance of nearly 2 miles. As nearly as could be observed, the aviator fell into a forest surrounded by bog land to the northeast of Verdun, not far from Douaumont fort; the wrecked biplane came to rest in the branches of some trees.

Immediately two automobile drivers volunteered to go in search of the dead man's body. One of the cars failed to return: it was hit by a shell and its occupants perished. The other came back a couple of hours later with the almost unrecognizable remains of the man who had gone forth that morning rejoicing in life and confident in his power to overcome all difficulties. The medical examination showed that Boillot had received a bullet in the head and another through the heart; it was thus only a corpse which had been thrown into space as the aeroplane capsized. The following morning a simple military funeral took place at the village of Vadelaincourt, 4 miles to the south of Verdun. There were present only officers and men from the aviation corps. No civilians entered that rapidly filling cemetery; not even the dead man's wife, father, mother, and brother had been allowed to penetrate that death stricken zone. As the burial party moved out of the graveyard shells began to fall around the place.

There are men who have won as many automobile races as Georges Boillot, but not one who managed to bring himself so prominently before the public or to secure such an incontestable right to the title of Speed King. Boillot's beginnings were modest. Born in Paris 30 years ago of parents of moderate means, he first worked in the dry goods trade, but had an ambition to become a professional cyclist. He figured as an amateur, and ran in a few amateur bicycle races, but had to recognize that he had not the time or the means to train for the profession. He entered the Peugeot factory as a mechanic and was later transferred to the drawing office of the main establishment at Audincourt.

Soon after completing his compulsory military service, Georges Boillot joined the Lion Peugeot racing team, winning fame at Dieppe and Boulogne. In 1911 the Peugeot company decided to run in the big car races and Boillot became head of the team. Goux was his lieutenant, Paul Zuccarelli was called in, and technical matters were in the hands of Ernest Henry, a young Swiss engineer who knew everything about high-efficiency motors but little about chassis.

His Rise to Fame

This new team set to work building cars for the French Grand Prix of 1912. Boillot won that 2-day race at Dieppe, defeating, among others, Louis Wagner and David Bruce-Brown. Working in the same way, Boillot's team won first and second places in the 1913 Grand Prix. By this time Boillot was recognized as the best driver in Europe and the racing Peugeots were the most-copied cars in the world Mercedes team-work beat him in the 1914 race, his car going out with a broken valve toward the end of the race.

Boillot visited America only once, for the Indianapolis 500-mile race in 1914.

Preparedness and Motor Trucks—Part II

Special Military Vehicles Such as Automobile Searchlights, Kitchens, Ambulances and Repair Shops—Use of Motor Buses as Transports

By Donald McLeod Lay

PRACTICALLY all special army vehicles have twin pneumatic tires on the rear with a housing around them brought as low as possible compatible with clearance. In some cases band tires are fitted on the front wheels without protection, the wheels being either cast steel or steel disks. Other special machines are motor work shops, aeroplane tenders and trailers.

Use of Disk Wheels by Italians

A distinctive feature of Italian construction is the use of disk wheels for trucks up to 2-ton load. These are detachable by unscrewing five or six nuts and are easy and cheap to construct, consisting merely of a stamped steel disk riveted and welded to a steel rim.

The trucks most frequently used by the Italian army are 4-tonners, while the smallest are 1-ton trucks on pneumatic tires generally with twin tires on the rear wheels. The Italian army employs a much greater proportion of pneumatic trucks than any other European army due to the adaptation of touring car chassis to truck work instead of having special truck designs. This arrangement is not most economical because all Italian trucks are driven too fast and tire upkeep is enormous.

At the end of the first 7 weeks of the war the motor transport service had settled down to business, and the weaklings and unsuitable types which were pressed into service too hurriedly had been abandoned and replaced by new trucks from the English factories. Classification of the trucks had also been made so that it was no longer necessary for 5 m.p.h. machines to keep pace with 12 m.p.h. vehicles.

Originally, the plan was to make use of motor trucks for carrying supplies from the railhead to a point a couple of miles back of the firing line from which point distribution was made to the men by horse-drawn wagons. Before October, 1914, this plan had been altered, the trucks going right up to the firing line and delivering direct to the men in the trenches. This system exposed the trucks to fire and caused several to be lost, but the time gained was considered sufficient justification for its continuance.

A motor convoy under fire is in less danger than a number of horse-drawn wagons, and although the trucks are far from bullet-proof, it is surprisingly difficult to put them out of business, many of those at the front being speckled all over with shrapnel shot without having their running qualities affected in the least. Compared with the horse, the modern motor is a very small target, and unless a bullet strikes the cylinders or goes through the radiator the vehicle is not likely to be incapacitated. Automobile captures were rare during the early part of the war, the vehicles being wrecked when it was necessary to abandon them.

Ambulance removing wounded French soldiers from the front

Comparing the mobility of troops and supplies where automobiles and motor trucks are used instead of railroad trains, it was stated in November, 1914, that "it takes little to disorganize a railroad, while it is practically impossible to disorganize automobile service."

By the end of October, 1914, it was reported that 3000 American-built motor trucks had been bought for war purposes by the belligerent powers, the bulk of these being fitted with wagon bodies having sides and tail board hinged to swing downward, the sides being provided with chains to hold them in a horizontal position and to make loading and unloading easy. Usually these bodies were supplied with a tarpaulin top supported by a series of removable semi-circular metal bows fitting into brackets at the sides of the body, the whole top looking somewhat like a prairie schooner. Some of the trucks carried bodies of the Russian design in which the platform is not horizontal, the floor bowing down in the center so that it has an arc shape instead of being flat. This is done in order that the loads carried press toward the center, thus avoiding any tendency to slip off at the side.

A Difference of Opinion

All French purchases of American trucks were for 2 and 3-ton models, the orders for 4 and 5-ton trucks coming from English army authorities, showing the difference of opinion as to the value of the two types. Owing to the deteriorated roads, W. F. Bradley pointed out, in February, 1915, that the 3-ton load could be handled with greater advantage.

After the English impressed trucks were sent into France they were painted gray to cover the advertising matter which usually decorated them, and more attention was paid to the protection of the drivers, a high, curved dash surmounted by a leather apron on both front and sides, entirely covering the steering wheel, so that with the substantial wood roof extension the men were well protected from the weather.

French Buses Superior

The Paris and London motor buses were used extensively early in the war for transporting troops, the Paris buses carrying forty men apiece. The London buses were found to over-heat when put to heavy work while the vehicles were incapable of hauling others of equal load and weight. Springs broke frequently, and in fact the English bus chassis proved inferior to the French, which was designed with war service as a possibility. It was merely a case of over specialization.

Motor Ambulances Are Efficient

The motor ambulance most generally used early in the war was a 20-hp. touring car chassis fitted with a large capacity canvas body having mica windows. The body was

of sufficient size to carry four stretchers in two tiers, leaving a space down the center for the ambulance attendant. These ambulances would go as close to the firing line as possible, load up with wounded brought in by stretcher men and carry them to the rail head or general headquarters, where they were attended in temporary hospitals before being carried to the rear by trains and finally distributed to the hospitals by more automobile ambulances. The great defect in the organization at that time was the inadequacy of the motor system for removing men from the hospitals just behind the firing line, wounded men frequently having to spend 15 to 20 hr. lying on straw in freight trains when touring cars could have brought them back in 3 to 4 hr.

Heating the Ambulances

The Ford ambulances used by the American ambulance corps in France did excellent service. These consisted of the standard Ford chassis fitted with an ambulance body of wood and canvas capable of receiving a couple of army type stretchers or to carry four wounded men sitting, thus making with the driver and attendant a maximum load of six. For heating these in cold weather a section of stove pipe, bound with asbestos and with the ends closed, was fitted around the exhaust pipe, a lead carrying the heat to a grating in the floor of the car.

Automobile Searchlights Employed

Automobile searchlights form an important branch of the French army, the electric searchlights being mounted on large touring car chassis, the current being generated by dynamo driven from the automobile engine. Six vehicles formed a working section, including a workshop and general stores truck capable of making repairs in the field. These machines were all painted grayish green, to render them inconspicuous. Some of the outfits were arranged so that the searchlight could be carried some distance from the automobile, one having a light steel telescopic tower permitting the light to be raised to a height of 40 ft.

Another way in which motor trucks were utilized was as traveling kitchens, being fitted with a stove and the cook preparing meals while on the road, thus saving time and increasing the comfort of the men.

Handling of Repair Work

After four months of war the repair department was shipping all kinds of vehicles, French, English, German, etc., to a big repair depot 100 miles from the front, where the uninjured parts of the vehicles were utilized in building composite machines if it was impossible to repair them. At this depot there were work shops but no machine tools, most of the truck repairs being undertaken by the car and truck factories.

Mobile repair shops consisting of two or three trucks completely equipped with machine tools, etc., were found to

Wreckage of motor trucks and cars at a repair depot

operate most effectively 25 miles from the front, it generally being possible to convert buildings, at various points, into repair shops, the equipment being readily shifted from point to point.

Types of Mobile Workshops

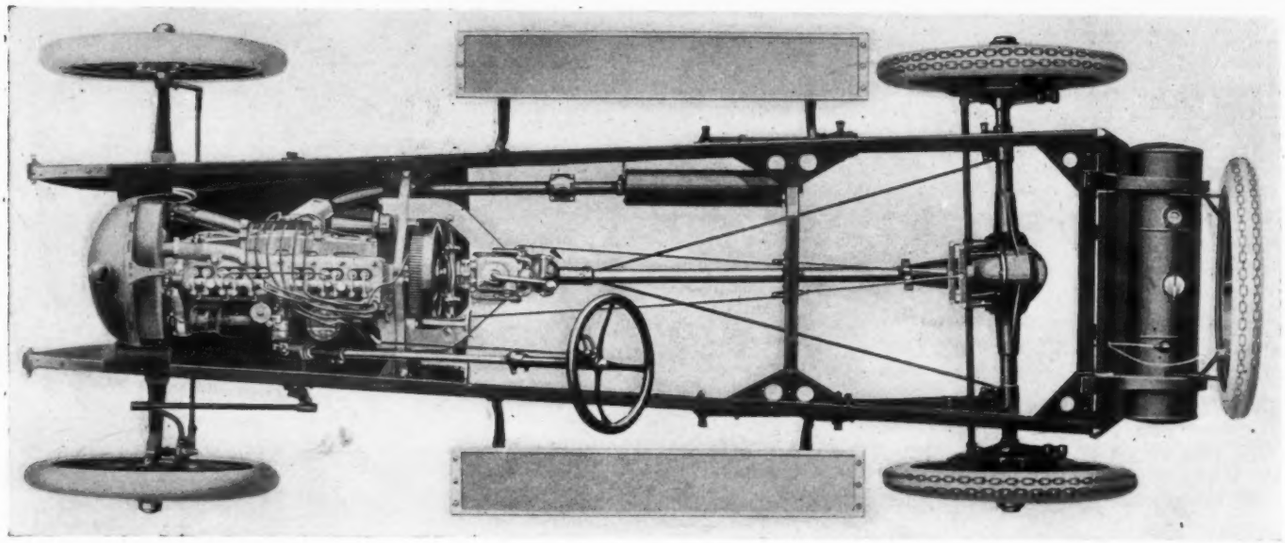
Each division of the British army motor service included three or four motor workshops kept in the open air garage at the depot town. These shops consisted of a heavily built high-wheeled van with sides opening outward on hinges so as to increase the floor space. The roof was made to open, being covered by a waterproof canvas blind on rollers which served to make the whole vehicle waterproof when closed up and also being capable of spreading out as a sunshade. These trucks were drawn by steam tractors and were completely fitted with machine tools, lathe, forge, drills, saws, etc., and obtaining its power from a single-cylinder motor on the ground under the workshop with a belt through the floor.

French Workshops Smaller

The French workshop was smaller than the English, being an automobile chassis with a workshop body, the motor serving both to drive the vehicle and to drive the machinery.

About 50 per cent of the truck casualties were caused by trucks bumping into the machine ahead when operating in convoy formation. Radiator protections must be very strong and fitted with powerful coil springs, the ordinary type of bumper being insufficient. Radiators on armored cars are especially vulnerable points and should be protected from bullets, collisions, etc., without impairing their cooling abilities. Of course, other motor vehicles are likely to be similarly injured and at least some protection should be afforded the radiators, especially if the machines are used anywhere near the firing line.

Left—Buick with a powerful searchlight for aircraft work. Right— Ambulance corps sheltered from aeroplanes in clump of trees



The Grant six chassis for 1917. Note that the valve rocker cover plate has been eliminated, as the car owner frequently failed to remove it to oil the valve mechanism. A Wagner electric system and a Stromberg carbureter are fitted for the coming season

Better Bodies Feature 1917 Grant

Fitting of Wagner Two-Unit Electric System and Stromberg Carbureter, Dropping of Valve Rocker Cover Plate and Quieter Operation Other New Developments

AMONG the first to make announcements of new cars for the coming season is the Grant Motor Car Corp., now located at Findlay, Ohio, but which is shortly to move to Cleveland. This concern has lifted the veil from what is undoubtedly the best-looking vehicle yet produced under the Grant name. It is model K, and is entering the moderate-priced six-cylinder field for the 1917 selling year.

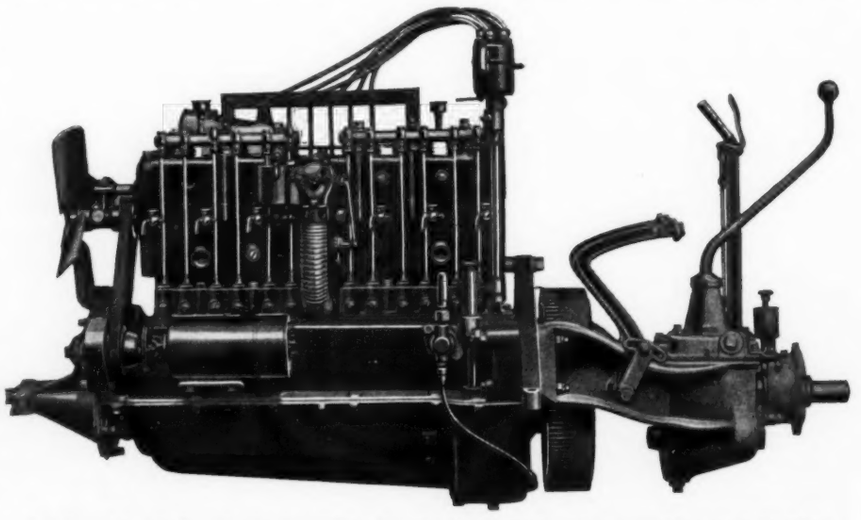
Although the most noticeable change over the previous Grant six is in the body lines, there are a number of other improvements that help to make it a better car. A Wagner two-unit starting and lighting system replaces the single-unit system formerly used, and likewise Remy ignition is fitted instead of the make employed for 1916. Stromberg carburetion is also given a place along with a change in the fuel system from the cowl tank to a reservoir at the rear from which the gasoline is drawn by Stewart vacuum feed. Larger brakes, minor changes in the instrument board arrangement, a larger steering wheel and a standard design of I-beam front axle are also changes of note.

Noise Is Minimized

The matter of silence has also been carefully looked into, and the Grant engineering department has gone over the entire chassis with the idea of making it quieter than its predecessor. This greater silence of operation has been brought about in the power plant, in the running gear and in the springs.

Practically no change has been made in the 3 by 4¼ overhead valve, block-cast engine with the exception of those minor differences due to the fitting of a separate starting motor and separate generator, and the use of a different carbureter. One unusual change is in the elimination of the cover plate that previously was fitted to the top of the cylinder block to house the rockers and valve stems. There is a good reason for this. It was found that in the hands of the average owner, the valve parts did not get the proper lubrication due to the fact that it was necessary to remove this cover plate to get at them. Although this was not a difficult thing to do at all, it was more trouble than some wanted to take, hence they neglected to lubricate the parts in question. So in order to make it as easy as possible to take care of the rockers and their bearings, it was decided to do away with the cover, and large and convenient oil cups are provided to take care of the proper lubrication of the rocker shafts, of which there are two.

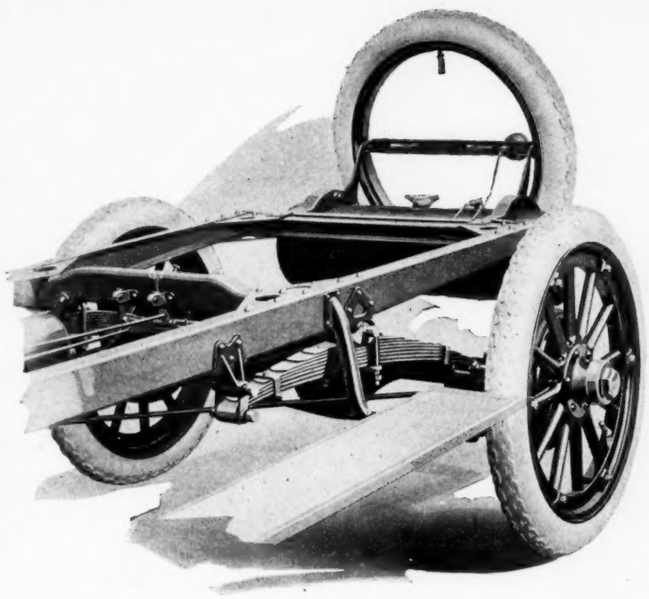
The new Stromberg carbureter connects directly to the



Intake side of Grant six for 1917, showing high carbureter mounting and ignition distributer. Note generator drive and hot-air connection for carbureter

cylinder head, with the distribution of gas to the several cylinders done within the casting itself. In the previous design, there were two inlet connections in the head unit, and a double-branch manifold connected externally from these to the carbureter. Now there is no external manifold whatever so far as the inlet of gas is concerned, and the new attachment permits of the carbureter being placed higher on the engine so that it is more readily accessible, to say nothing of being conducive to better carburetion because the gas has less distance to travel. This higher mounting is of course made possible, in a large measure, due to the removing of the gasoline tank from the cowl and placing it at the rear of the chassis. It was necessary to have a good head on the gasoline when it was fed by gravity in the previous model.

Although the make of ignition apparatus is changed to Remy, the method of drive and the location of the distributer are not changed. Driven off the end of the camshaft, the vertical distributer shaft occupies the left rear side, and the distributer is high enough to make it easy to reach, at the same time affording plenty of room over the top of the valve rockers to allow the wires to be run without interference to the plugs on the right side of the head, a supporting bracket being fitted which carries each ignition lead well out of the way of the valve parts.



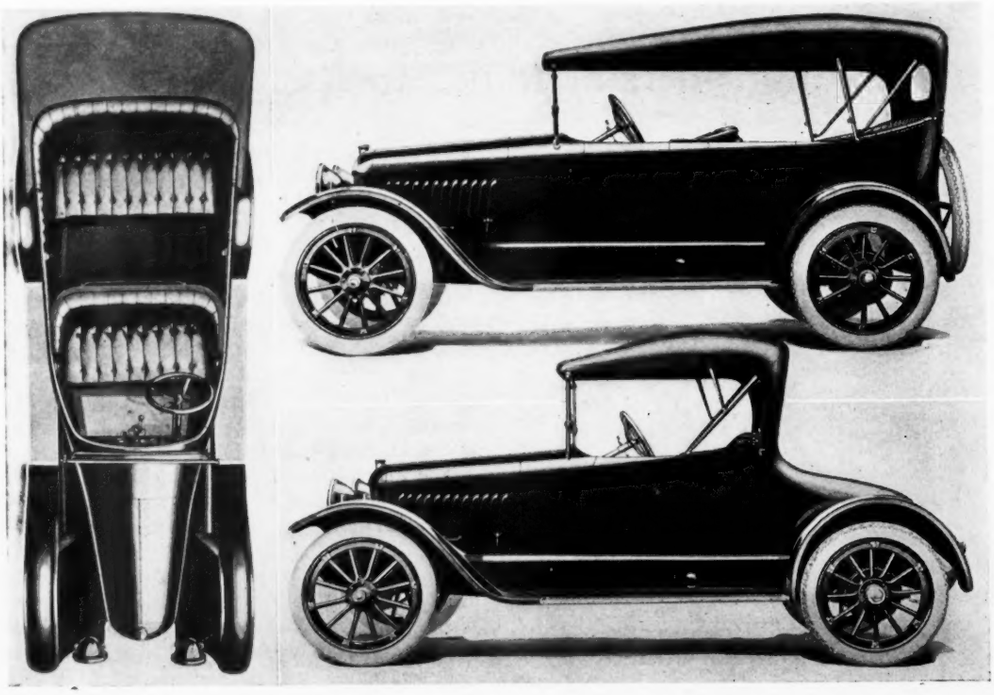
Rear construction of Grant six chassis, showing cantilever springs, gasoline tank mounting and tire carrier

Starting Motor Is Separate

Because the starting motor is a separate unit, it is mounted at the right rear side of the engine and the driving connection is made through the Bendix centrifugal-action device to teeth cut in the rim of the flywheel. The separate generator occupies the opposite side from its location on the 1916 engine, being mounted so as to be driven by an extension of the fan-driving shaft on the left, a leather universal coupling allowing for any slight variation in alignment and making a noiseless connection.

Reviewing some of the salient features of the motor, for the benefit of those who are not familiar with the Grant power plant construction, it should be mentioned that the unit is suspended in the frame at three points, the front end resting freely on the front cross member, and the rear being hung from a forged cross member just back of the cylinder block. The main cylinder casting and the upper part of the crankcase are one piece, this making a rigid and compact unit that carries the crankshaft and insures alignment of the cylinders and the shaft. The head casting, which carries the valves and their operating mechanism, is bolted to the main unit, and it is therefore a simple process to reach the cylinder walls and the pistons for inspection, cleaning, etc., when occasion demands.

Internally, standard practice has dictated the design throughout. There are three bearings for the crankshaft, these being of the ample diameter of 1 9/16 in., with the lengths 2 19/32, 2 and 3 in., from front to rear respectively. Pistons are made of cast iron and as light as is consistent, each carrying three rings. Three bearings are also provided for the camshaft, which has a diameter of ⅞ in.—ample for an engine of this size—and the cams are so shaped that quiet action is one of the first considerations. One nice feature of the valve assembly is the provision for removal of the tappets and their bushings from the top of the crankcase outside. The tappet assembly for three cylinders is made a unit so far as the mounting is concerned, and by the removal of six holding bolts this can be lifted out bodily.



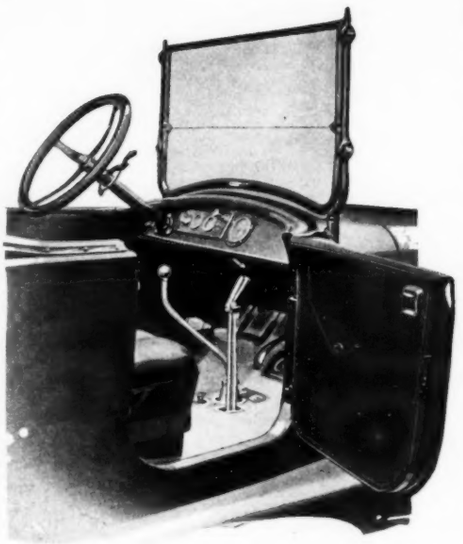
Grant touring car and roadster for 1917, showing the new body lines. These models sell for $825 and there is also a cabriolet which lists at $1,050

Timing Gears Quiet

Timing gears are helically cut, the center gear being steel and the others cast iron, so that they run silently together.

Driven off the rear end of the camshaft is a plunger oil pump that draws the lubricant from the motor base after it has been strained, and delivers it through a dash sight feed and thence to the front gear case and to the rear of the engine. From this point it overflows into the successive connecting-rod troughs and eventually runs back into the reservoir at the bottom. An oil level indicator, which is neatly formed as a part of the oil pump case, tells the quantity in the reservoir. This is on the left side.

Thermo-syphon cooling is still advantageously adhered to in this car, the radiator being assisted by a pressed-steel six-bladed fan which is driven by a belt, as already mentioned, there being the customary adjustment at the fan mounting for taking up any slack that may develop in the leather. Grant is still using the characteristic rounded-front radiator, which is of a special tubular form, as in previous models.



Driver's compartment of the 1917 Grant, showing the wide door and the arrangement of the control levers. Note the simplified instrument board

The method of attaching the gearset to the rear of the motor by means of two drop-forged arms has not been changed. This mounting leaves the flywheel open, and is a factor for reducing weight to the minimum. The gear assembly is a compact unit having the usual three speeds ahead. To give an idea of its ruggedness, and to make the unit as compact as possible, the countershaft gears are cut integral with their shaft, the forging being blanked out as a single piece. The gears have ⅝-in. face and are of the stub-tooth shape, and in mounting their shafts a double-row ball bearing carries the front end of the mainshaft, a single ball bearing the rear end.

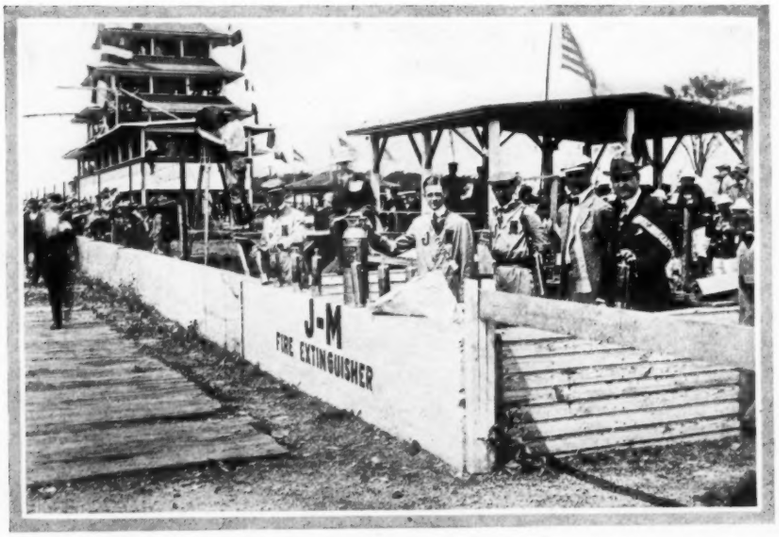
Grant maintains the form of final drive in which the power first goes through a cone clutch, the gearset, then a universal and eventually through an inclosed propeller shaft. The torsion tube inclosing the latter is light and strong to carry the drive and torque and presents a most compact appearance with the rear end swaged out to meet the axle housing. The axle is floating, with means for gear adjustment on removal of the rear inspection plate, this applying also to the driving pinion. A gear ratio of 4½ to 1 is used.

Although the diameter of the brakes has been considerably enlarged, from 10½ to 12 in., there is no other change of importance in the braking system. The equalizer bars are carried at the rear axle on the brake operating rods that are attached forward of the axle tubes. By bringing the equalizers all the way back, side brake operating rods are eliminated, only one control rod from each brake control running back from the supporting cross member.

In connection with the running gear, the previously used front axle, which, though it was of I-beam section, was fitted with some specially-designed steering knuckle mountings and features, is replaced by a standard form with strong and stout steering connections throughout. Nothing has been changed in the rear cantilever spring suspension. These members are 38 in. long by 2 in. wide and give free action due to the trunnioning of the center directly under the frame member and the shackling of the front end, with flexible mounting to the axle tube as well. No change has been made in the 112-in. wheelbase, nor in the tire size, which is 32 by 3½, with non-skids on the rear.

Besides the roadster and touring body types, Grant is offering a cabriolet model as well. The prices are $825 for the two open models and $1,050 for the cabriolet.

J-M Fire Extinguishers at Indianapolis Race



Headquarters of the J-M fire extinguisher brigade at the Indianapolis International Sweepstakes May 30. There were fifty-four J-M men distributed through the grandstands and pits and around the track

HIGH speeds and the hot weather which has come to be considered characteristic of Memorial Day, and the almost invariable accompaniment of the annual International Sweepstakes race on the Indianapolis speedway, constitute very favorable conditions for outbreaks of fire upon either the overheated cars or the track itself. The accompanying illustration shows the headquarters occupied by the extinguisher brigade of the H. W. Johns-Manville Co., New York City, at the recent Hoosier classic which was won by Resta in the Peugeot.

The Johns-Manville company had fifty-four men on the grounds during the running of the race, distributed through the grandstand and the pits and stationed at various points around the track armed with J-M extinguishers. Both the accidents which occurred took place near the J-M service station and, although the men were not called upon to use their extinguishers, they rendered aid to the injured drivers and their mechanicians until the arrival of medical authorities.

The History of the Pneumatic Tire—6

Efforts To Preserve Cushioning Effect While Protecting the Rubber—The Carmont Clincher Tire—Other Interesting Patents — First Pneumatic Tires for Bicycles

The History of the American Automobile Industry—33

By David Beecroft

THE wired method of construction in which the round rubber cord or tire was held in place by a sheet steel jacket, which jacket had ears that extended radially alongside the felloe and were provided with slots and pins by which they were held to the felloe but permitted movement as the rubber under the jacket compressed was one of many attempts to get the cushion effect but protect the rubber from the effect of the road. Inventors who seek this supposed advantage do not know that rubber is quite long-lived; sometimes more so than steel, when exposed to gritty service. The steel being unyielding is scratched or chipped by every contact with sharp stones, whereas the rubber simply yields, and if not loaded beyond its strength comes back to its original shape without losing any material.

The Carmont Patent

The Carmont tire, patented in June, 1887, was a clincher type, solid tire. It had a very wide base and was fitted into a rim much wider than the tire so that it could not roll out or turn over easily. In its center, at the base portion, was a V-shaped groove intended to permit the rubber to yield, the inventor seeming to have known what many experimenters at that time did not, that rubber is practically incompressible. Many later forms embodied this same idea, but the movement of the rubber within the rim often damaged it and eventually caused the tire to come off.

The year 1888 showed a number of patents which afterward became prominent in the pneumatic tire industry. The first of these, to Thomas B. Jeffery, late of the Thomas B. Jeffery Co., in May, was held in a clincher rim by little studs or projections of some harder material, such as metal rivets, which, engaging the overhanging edges of the rim, held the tire in place. In June, a half dozen or more patents were issued to A. W. Thomas and were strictly of the pneumatic variety. Their general principle involved the casing separate from the tube, which casing was held to the rim in some mechanical manner, such as by clamps. Two more patents were issued to Thomas in 1889. These Thomas patents were taken up by George R. Bidwell a couple of years later and the first real manufacturing of pneumatic tires in the United States was begun. Bidwell combined with the Thomas patents a license from the English Dunlop people which had been given to A. Featherstone of Chicago, and believed that he controlled the tire business in America. A factory was established at Sixty-sixth Street, near Columbus Avenue, New York City, and orders were placed with the New Jersey Car Spring & Rubber Co. of Jersey City, N. J., as well as with the B. F. Goodrich Co. of Akron, Ohio. These orders, given in March or April, 1891, were the beginning of the now enormous business of the Goodrich company.

Dubois Solid Tires

In 1888 the Dubois Mfg. Co., of Philadelphia, secured patents on solid rubber tires, one form being D-shaped, held in place by a flat band or wire placed in a hole near the base of the tire. The other was simply a rubber cushion of practically rectangular shape set into a flanged rim and having a groove in its outer surface. Into this groove a steel rim of T section was forced and held in place by the groove. This device was practically a copy of the Dietz device of 1835, excepting for the groove in the rubber and the stem on the metal for holding the two parts together. This stem undoubtedly stiffened the metal very materially and probably rendered the supposed cushioning action less evident. The form retained by the flat band proved more practical and was frequently seen in use in later years.

Other Cushion Types

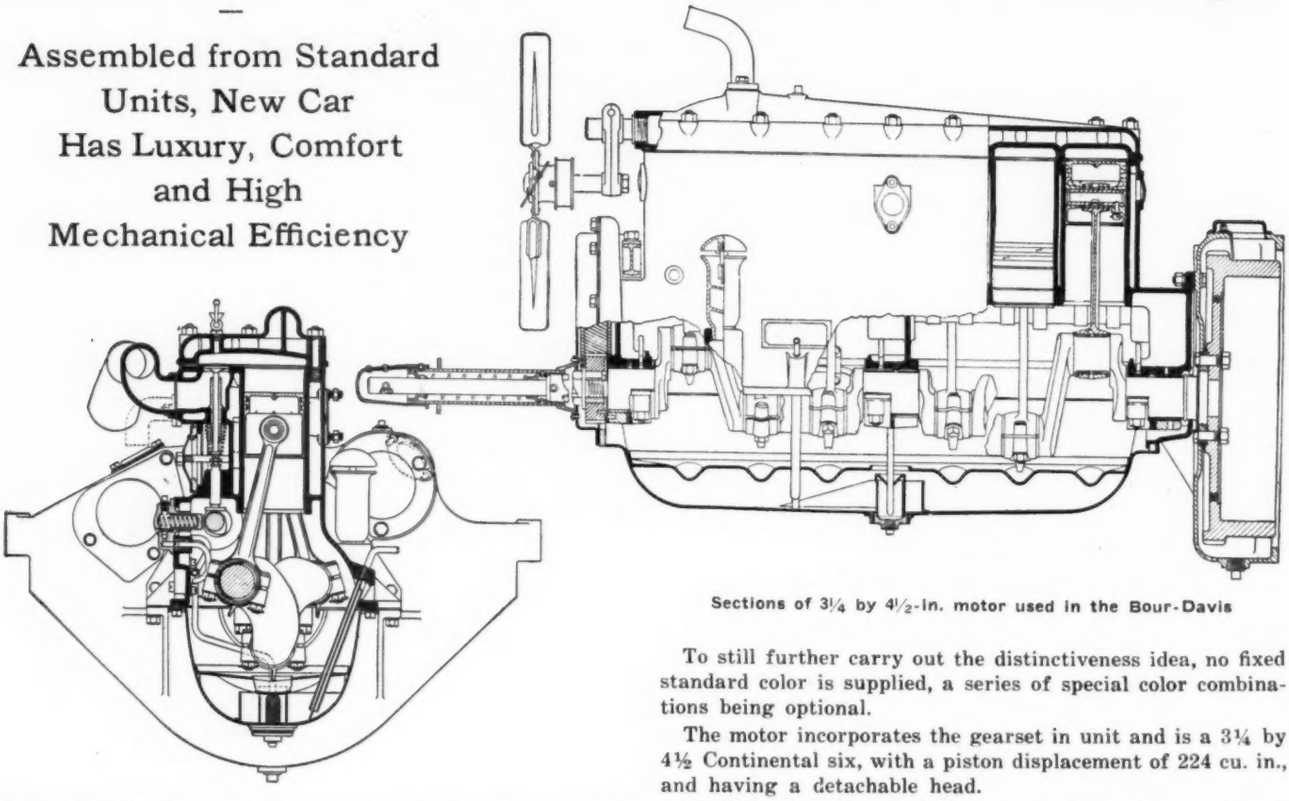
In 1889 we find a cushion tire having a thin sheet of metal in its base and adapted to be forced into a hooked or clincher rim. This was followed by a number of tires in which the crosswise stiffness of the base was expected to hold the tire beads in their places under the hooks of the rim after they were once placed there and until the central portion of the base should be lifted or pushed upward, which permitted the tire to be removed.

Pneumatic Bicycle Tires

In 1889 the first pneumatic-tired bicycles reached this country from England and their introduction was the first use of the air tire in America. This shipment was three New Rapids bicycles from the St. Georges' Engineering Co. to Samuel T. Clark, of Baltimore, Md.

Bour-Davis Six a Distinctive Design

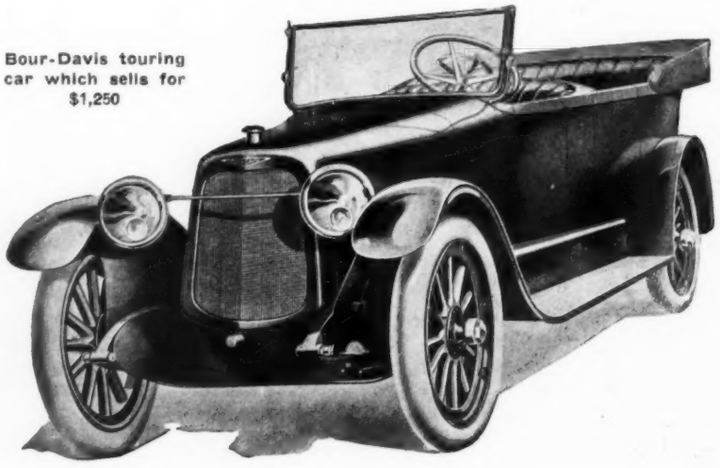
Assembled from Standard Units, New Car Has Luxury, Comfort and High Mechanical Efficiency



Sections of 3¼ by 4½-in. motor used in the Bour-Davis

DESIGNED to meet the requirements of that class of buyers which demands luxury of appointments, finish and detail in a car, along with distinctiveness and individuality, in addition to efficient mechanical construction, the Bour-Davis, which is the product of the Bour-Davis Motor Car Co., one of Detroit's newcomers within the past year, is now formally placed before the public. The thought of the builders in producing the car was to fill the gap in the price class for the luxury type of car between the low-priced type and the high-priced vehicles. The price has been set at $1,250 for the touring car and $1,500 for the inclosed type, the only other form of body offered on the chassis for the present.

The car is a roomy vehicle, made up of standard parts. The motor is a Continental; the gearset is produced by the Detroit Gear & Machine Co.; Borg & Beck make the clutch; Remy supplies the ignition; Stromberg the carbureter, and Ward-Leonard builds the lighting and starting system. Some unusual equipment features are a roomy luggage trunk at the rear, Motometer for determining the water temperature, rear-vision mirror, windshield cleaner, in addition to the generally accepted requisites of the car of to-day.



Bour-Davis touring car which sells for $1,250

To still further carry out the distinctiveness idea, no fixed standard color is supplied, a series of special color combinations being optional.

The motor incorporates the gearset in unit and is a 3¼ by 4½ Continental six, with a piston displacement of 224 cu. in., and having a detachable head.

Crankshaft and camshaft are well mounted to insure minimum of vibration, and each has three bearings. The crankshaft bearings are bronze-backed and babbitt-lined, and their ample proportions are indicated by the dimensions: 2 9/32 by 2½ in., 2¼ by 2⅞ in., and 2 7/32 by 2 15/16 in., these being the front, center and rear respectively, and the first figure in each case representing the diameter. One of the essential features of efficient motor operation is a substantial camshaft that cannot be distorted, and in this motor the point has been well considered, for the dimensions of the bearings are quite large. The diameters are 1⅞, 1 13/16 and 1 11/16, and the lengths 2½, 2½ and 2 11/16 in., front to rear respectively. The cams have wide faces of ¾ in., and the shaft is driven by helical gears.

To promote smooth running with a minimum of vibration, the connecting-rod and piston assemblies are all weighed and the six that enter into the construction of any one engine are of the same weight. The rod runs in bushings at both ends, that at the piston end being of bronze and at the shaft end of die-cast babbitt.

A cam-operated oil pump feeds the lubricant to the bearings and to troughs, from which it is splashed by the rod ends to the various other

bearing surfaces within the engine. This is the conventional force-feed and splash combination with which Continental has been very successful. The oil capacity of the pressed steel oil pan that forms the bottom of the motor is 5 qt., the amount held at any time being indicated by a dial.

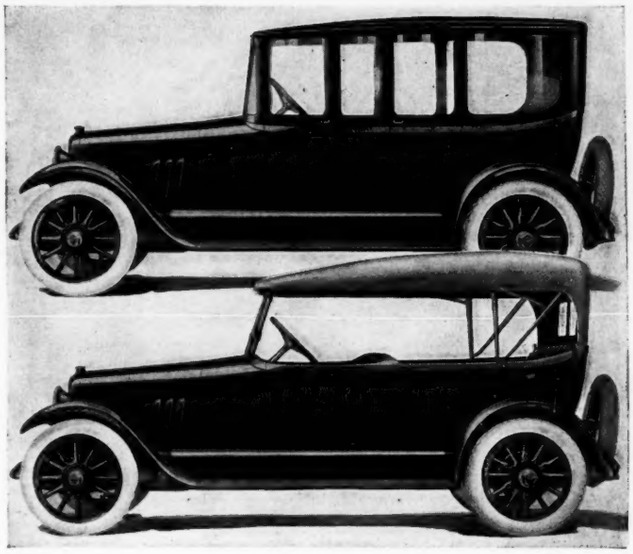
On the right of the engine and forward is the centrifugal water pump which is driven from the timing gears by a shaft. Between this unit and the cylinder block and the radiator the piping is therefore short, with obvious advantage. The water outlet is formed in the head casting and is also forward so that there is only a short pipe connection to the radiator. There is a belt-driven fan at the front, the belt tension being adjustable.

Ignition, starting and lighting units are separate. That is, a two-unit Ward Leonard equipment is provided for furnishing the lights and starting, while a Remy high-tension coil and distributer are used for ignition. The starting motor drives through teeth in the flywheel, meshing and demeshing of the starter pinion and the flywheel teeth being accomplished by the Bendix automatic device. It is only necessary to press the starting button, when the revolving of the motor armature automatically throws the pinion into mesh with the gear, and the operation is reversed when the engine starts under its own power. The generator is driven by the front gears, and connects to a 6-volt, 80-amp.-hr. battery.

In the gasoline system there is combined a Stromberg horizontal-outlet carbureter with a Stewart vacuum feed tank mounted on the front of the dash. The gasoline supply tank is carried at the rear of the chassis, and a very commendable feature of its mounting is the three-point suspension employed so that it does not have to take the strains resulting from any frame weaving, as would be the case were it rigidly mounted.

Back of the engine, the drive passes through a 10-in. disk clutch and the compact unit gearset, in which gears and shafting are of chrome-nickel steel, and the shaft mountings are annular ball and Hyatt roller bearings, there being provision for taking up wear. The spool type of countershaft with its stationary spindle assures smooth and noiseless action and prevents oil leakage. The speedometer gear is driven by the transmission shaft.

In the rear axle, which is of the three-quarter floating construction, nickel-steel spiral bevel gears are used to promote silence and smoothness of operation. Artillery wood wheels are standard equipment, and they carry 32 by 4 tires on demountable rims.



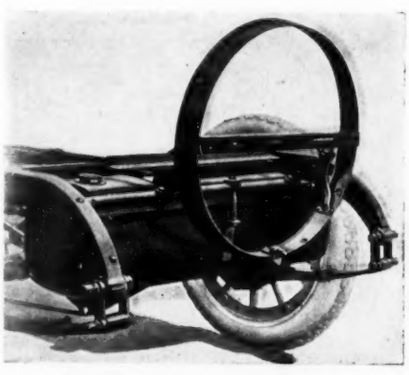
Above—Bour-Davis closed car which sells for $1,500. Below—Touring car model with the top up

Springs, both front and rear, are semi-elliptic and self-lubricating. The front pair is 37½ in. long, and holds the front end of the car in castor fashion, thus counteracting the road shocks. The rear ends of the frame rails are bent down to hold the rear ends of the springs, which are 52 in. long and underslung from the axle.

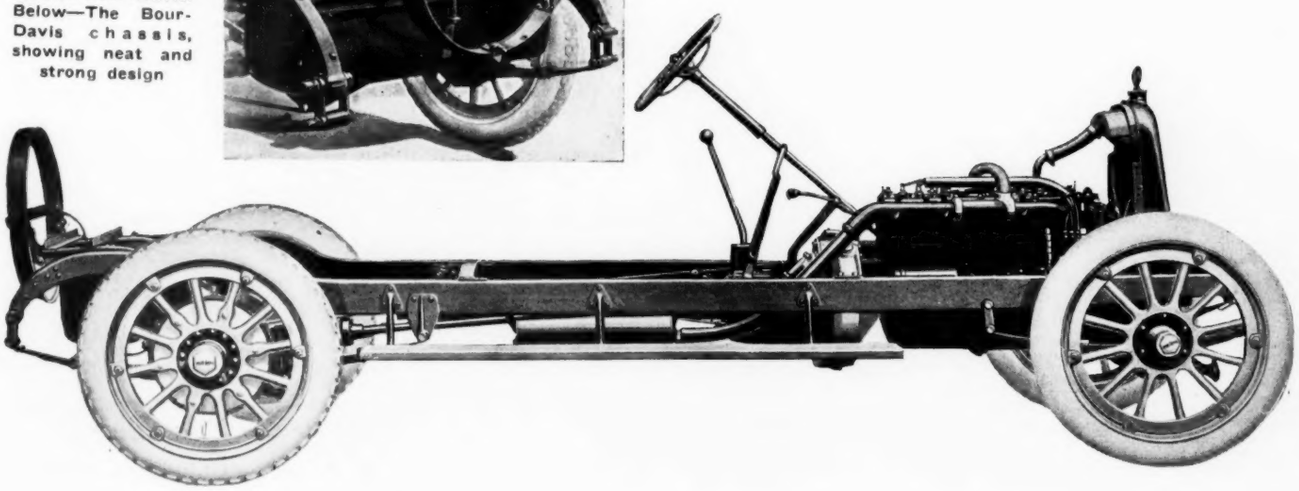
A tapered frame has been utilized, having a front width of 29⅛ in. and widening to an extreme rear width of 4½ in.

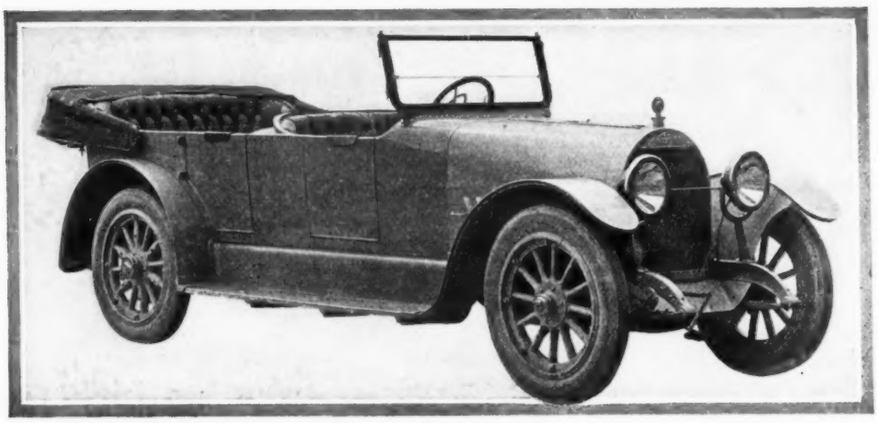
The wheelbase is 118 in. and there is plenty of leg room for comfort. The front seat is 14 in. high, 16½ in. deep and 42 in. wide, and the rear 14½ by 18 by 47 in. The angle that has been given the seats and the shaping is such that they are remarkably comfortable, the designers having this idea of comfort especially in mind when building the body.

Very excellent coach work has been given the body. The instrument board is finished in walnut, and the back of the front seat is attractively paneled, a feature that adds greatly to the general appearance. In connection with the equipment, one refinement is the combination dash and trouble lamp, this being normally a dash illuminator, but pulling out with 18 ft. of cord for trouble use.



Right — Tank support, showing spring suspension, tire carrier and trunk rack on Bour-Davis. Below—The Bour-Davis chassis, showing neat and strong design



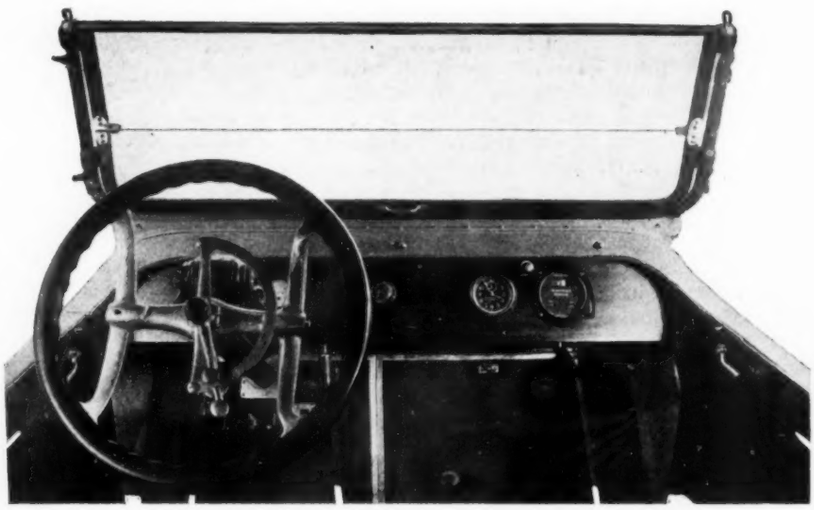


The 1917 McFarlan selling at $3,200

1917 McFarlan Chassis—A

Built 4 in. Nearer the Ground Wheelbase Is 4 in. Longer—More Powerful and Livelier

MANY improvements distingush the new series X McFarlan, manufactured by the McFarlan Motor Co., Connersville, Ind., the company concentrating on this chassis for 1917 and discontinuing the model T chassis. The new car is striking in appearance, having a very low-hung effect, while the body is roomier than the previous model, being 4 in. longer and 4 in. lower with the top of the body panel only 48 in. from the ground. There are a number of refinements in the chassis also. A six-cylinder, 4½ by 6-in. motor is used similar in design to that employed on McFarlan cars for 6 years. Owing to the improvements embodied in the new car as well as to the increased cost of materials, all open models are now $3,200, instead of $2,990, or $210 higher.



Driver's compartment. Note the tilting wheel and control box on the column

A Teetor power plant is used, and this has several refinements, giving a higher-powered and livelier motor for the same displacement. This has been accomplished by reducing the combustion chamber volume, thus increasing the compression 10 lb., or from 60 to 70 lb., and by providing a new cam action which gives a quicker inlet opening; also the tappets are lighter. The valves are inclined and enter the cylinder at an angle.

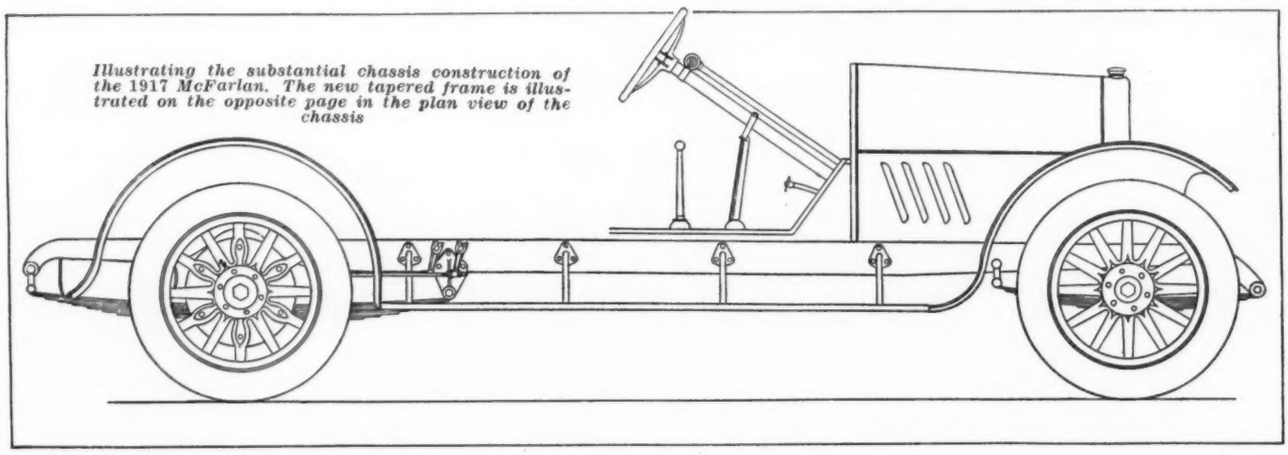
While the bore and stroke remain the same, the connecting-rods are now 12½ in. instead of 10 in.

The spark plugs are now in the centers of the cylinders, designed to act in conjunction with the higher compression in producing more efficient combustion. Another change in the cylinder block is that the cooling water enters at two places below the exhaust valves instead of one. The water pump is now on the right side instead of the left. The exhaust manifold is now a separate casting.

A three plate dry clutch has replaced the cone, requiring a pedal pressure of only 6 lb.

The Brown-Lipe gearbox is still used, but in place of the annular ball bearings it is equipped with Timken bearings throughout. The propeller shaft is now hollow and the universals are Spicers, with one between clutch and gearbox.

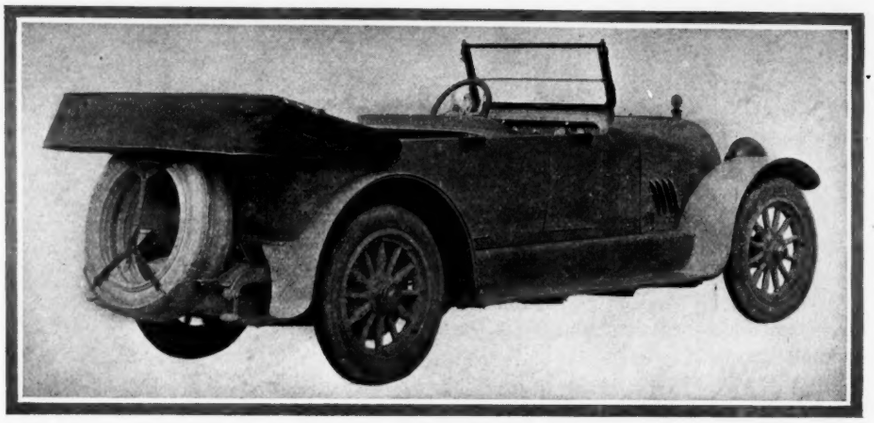
Both front and rear axles are Timken. The front axle carries a bearing in the knuckle and the rear axle operates through a splined shaft. On the rear system a change of



Illustrating the substantial chassis construction of the 1917 McFarlan. The new tapered frame is illustrated on the opposite page in the plan view of the chassis

Built on Single Bigger Car

Than the Previous Model and Higher Compression Gives Motor—Elegance and Comfort



Spare tires are compactly mounted and the mudguard blends into the body

The 1917 McFarlan is built 4 in. lower than its predecessor

importance is in the brakes, which are 17 by 2½ in., instead of 16 by 2½.

The new frame is drawn in at the front in bottle-neck fashion to give a short turning radius. It tapers back to a width of 40 in., and there is a kickup over the rear axle.

The suspension of the car has been changed front and rear. In the front the springs are semi-elliptic, 40 in. in length. The rear has been changed from a 56-in. cantilever to a 62-in. underslung semi-elliptic. The new rear springs take both thrust and torque, giving a full Hotchkiss drive. Bronze bushings have been placed throughout the car at all wearing points. In spite of the changes, the car weighs 300 lb. less than for 1916. Also, the wheelbase is now 136 in., as against 132 in. Aluminum pistons are continued.

Curved cheek counterbalancing is used on the 2⅛-in.-diameter crankshaft, which is supported on four main bearings. The dimensions of these are 4¼ in. long by 2⅛ in. diameter at the ends, and 1⅞ in. long by 2⅜ in. diameter at the center.

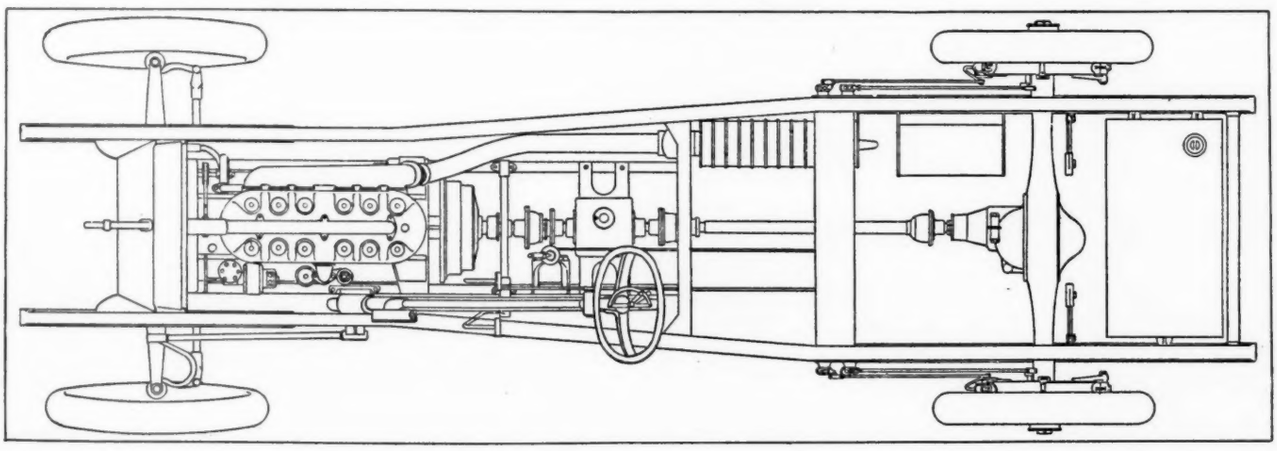
Lubrication is by combined force feed and splash. The oil is fed to the main bearings under a pressure which varies from 5 to 30 lb. under different engine speeds. The connecting-rods and cylinders are taken care of by the Teetor patented system, in which the splash level is variable and controlled by gravity.

The electrical system is centralized in a control box on the steering column, and all wiring is in the chassis, so it is only necessary to pull out two connectors when changing bodies. The steering wheel tilts and is equipped with an electric warming device for winter driving.

Electrically the entire car is Westinghouse. The generator and ignition unit is mounted on the left side of the engine and the starting motor is on the rear at the right side.

The body is of the true double cowl, streamline design, with the exception that the front backs are raised slightly out of this cowl to allow a higher and heavier upholstering than has formerly been used. The same scheme has been followed out in the rear seat; the raise, however, being completely hidden by the back curtain and back stays which are carried around the corner of the body.

The auxiliary seats fold into a cabinet and are hidden by flexible wooden curtains.



ACCESSORIES

Cozy Camp Trailer

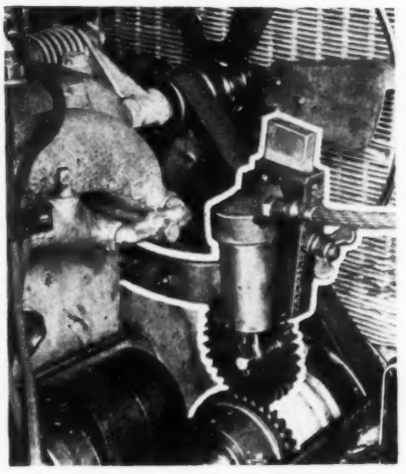
THIS combination trailer and camp outfit, as may be seen from the accompanying illustrations, is of neat design and strong construction while the equipment is very complete. The trailer is fitted with selected second growth hickory and solid rubber tires, the axle being 1¼ in. diameter of high grade specially tested steel with ball bearing spindles. Springs are of platform style with hard wood cross sills providing support for the body, which has high side and end panels strongly braced with wrought iron. It contains the built-in removable refrigerator and removable drawers for carrying accessories. The tent is of heavy, closely woven waterproof duck with screened skylights for ventilation and light. The equipment comprises two double spring beds for large bed mattresses, table, cook stove and the refrigerator already mentioned, the maker reserving the right to alter the specifications in the matter of improvements. The maker provides a swivel hitch for attaching to cars on which it is possible to reshape the rear irons to suit. When this is not practicable, an axle hitch is furnished at the same price, the entire outfit including the trailer, the equipment specified and a rigid weatherproof canopy deck selling for $165 f.o.b. Indianapolis, $25 with order, balance on receipt of shipment.—Cozy Camp & Auto Trailer Co., Indianapolis, Ind.

Adams-Williams Convertible Top

This top consists of a set of glass sides which cover over the open space usually closed by the side curtains. It may be put up or taken down in 3 minutes it is said, and from the inside of the car. It is made for all cars. Prices, $60 and up.—Adams-Williams Mfg. Co., New York City.

Alben Jack and Crane

While this device resembles a portable crane with a bifurcated base and ball-bearing caster wheels, it differs in that the boom or arm to which the chain is attached moves upward bodily, the upright part sliding in a hollow column and being actuated by a hand-crank, through gearing. The gearing gives two speeds, one for heavy loads and the other for light loads and quick lowering. Another feature is a jack arrangement, consisting of a pair of arms hinged to the sliding upright, so that they can be inserted under the load and the load raised by turning the crank. The arms can be swung to any angle and can be moved back out of the way when not needed. Minimum boom height, 6 ft. 4 in.; maximum, 9 ft. 3 in.; length of jack arms, 26 in.; weight of complete machine, 300 lb. It sells for $85.—Alben Co., Milwaukee, Wis.



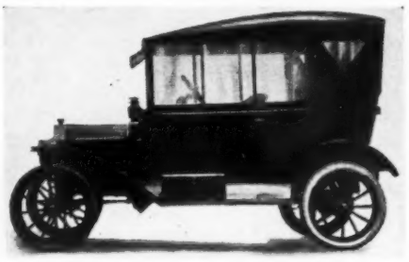
Juleco power pump for Maxwells

Juleco Pump for Maxwells

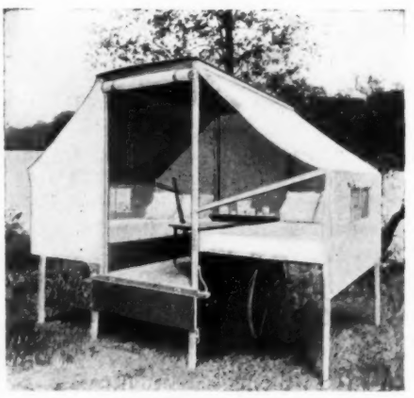
This pump has been brought out to supplement the Juleco line for Ford and Metz cars. The new design for Maxwells is similar to the Ford type and its efficiency is said to be practically the same. It is quickly attached without drilling or mutilating the car or engine in any way. being conveniently located behind the fan on the forward end of the motor as shown in the accompanying illustration, slides in and out of mesh very easily. Some of the features are: Pumps tires in 2 to 3 min. at 425 r.p.m.; has a Wear-Better plunger; requires little attention, only a few drops of oil on the bearings occasionally; satisfactory operation and all parts are guaranteed. Price, $6.—Judd & Leland Mfg. Co., Clifton Springs, N. Y.

Potstada Shear

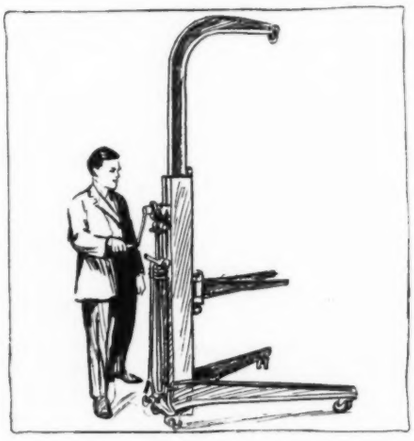
This bench shear for cutting metal will work steel plate ⅛ in. thick. The shear is of forged steel and the handles and stand of malleable iron. The stand has a lug for gripping in the vise. There are but seven parts in the tool and all are numbered for easy identification in case of breakage. Price, $7.50.—C. Groos, Racine, Wis.



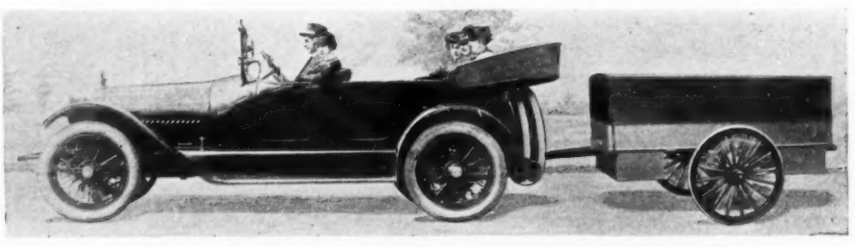
Adams-Williams top for Fords



The Cozy Camp outfit open



Alben combined lifting jack and crane



The Cozy Camp trailer outfit packed and attached to the car

The Automobile

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Military Transport

THE establishment of the military transport committee of the S. A. E. makes America the first country to tackle the problem of arranging for emergency in this regard along really rational lines. The German methods of preparation were good, but they are possible only in a country not blessed with a democratic form of government. The British subsidy scheme was a good conception, but it was developed without proper reference to the opinions of the men in the industry who would have made the best advisers. The almost complete uselessness of the scheme when it was put to the test in August, 1914, provides a lesson that American engineers and the American army have not been slow to realize.

Just exactly what will be the duties of the new S. A. E. committee is impossible to tell as yet, but in the main its purpose is to form a connecting link between the army authorities who are experts on the requirements and the industry which is expert in the design and construction of trucks.

The effect of the work to be done may not be noticeable for some time to come, but after several years it cannot help but raise the efficiency of preparedness from the transportation angle. Transportation is a chain which binds together the army and the suppliers, neither is any good without the other, and in that great chain the S. A. E. committee is one of the most important links.

The Best Yet

THE trip which the S. A. E. started on Monday last is unquestionably the best organized as well as the most largely attended excursion in the history of the Society. Its program of papers and discussions has never been approached for variety or for average excellence, and the subjects chosen have never been more closely in accord with the vital topics of the day.

One of the most striking things is the fact that the breadth of outlook indicated by the papers program is so entirely representative of the increasing breadth of the responsibility of the automobile industry. To-day the word "automobile" is coming to be regarded more in its true sense. Not only passenger cars, but trucks, tractors, aeroplanes and even motor boats are automobiles in the dictionary definition; they are self-propelling machines. There is no fundamental difference between the tractor and the aeroplanes, and a great fund of common knowledge is necessary in designing either one of them. This the S. A. E. has realized, just as the engineers themselves have realized it, and the trend of present events shows clearly that the past work of the society is being appreciated by both extremes of the profession.

Small Output

DESPITE the enormously increased productions of the past few years, and despite the tendency to group factories together so that the aggregate output is immense, it is still easy enough to obtain capital for a very different sort of car making. There are a good many firms now in existence making small quantities of very high grade cars, selling them at a very high price and with a big profit per car, but there are not so many small firms making a medium price vehicle.

The man who wants a really distinctive car of good, sound construction and whose limit of price is about $2,000 has not a great many machines from which to choose. He can get a wide range of models around $1,250, but is often willing to pay an extra few hundred to get something that is *not* produced in large quantities. Mechanically an excellent chassis can be assembled from the best parts for under $1,000 and it is then possible to make the retail price anything from $1,200 or $1,300 upward, according to the degree of finish on the body and the quality of the accessories. Lasting good finish is still not cheap, and first grade accessories command a price commensurate with their durability and good appearance. For the first class body and the highest grade of fittings many people are willing to pay; and they will pay, too, for a car which they can recognize as theirs from a distance of a couple of blocks.

To suit this class of consumer only a limited number of cars can be built, for a large output defeats the purpose of the maker. Thus, however large the major concerns in the industry may become, there is always sure to be room for a number of small factories producing medium price cars.

N. A. C. C. Approves Service and Repair Parts Policies—Defines Standard Truck

Puts Service Standards on Fair and Definite Basis with All Purchasers of Passenger and Commercial Vehicles —Policies Are Outcome of Service Managers' Convention

NEW YORK CITY, June 13—The National Automobile Chamber of Commerce has approved a form of standard service policy to be put into effect between the members and the purchasers of their cars, and has also approved a standard repair parts policy to become operative between the manufacturers and their distributors and dealers.

These two policies are the outcome of the service managers' convention held in Detroit last year, and embody the results of careful study and recommendations made by the service managers' associations of Indiana and Michigan, organized last year, and of the two special committees appointed by the N. A. C. C., of which Percy Owen (Liberty) and E. T. Klee (Stutz) were the chairmen.

The service policy is as follows:

N. A. C. C. STANDARD SERVICE POLICY

The Blank Motor Car Co., through its dealers, aims to give all purchasers of Blank cars uniformly fair, courteous and businesslike treatment and to assist them in every reasonable way to keep their cars in good running condition.

The principles of this policy are:

First—To fulfill the obligations assumed under the manufacturer's warranty.

Second—To furnish repair parts as promptly as possible at our current prices.

Third—To maintain facilities for making repairs, adjustments and do general overhauling in a prompt and competent manner at reasonable charges.

Fourth—To make inspections and adjustments, not necessitated by neglect or abuse, free of charge for 1 month following delivery of a new car to purchaser, and thereafter at our regular prices.

Fifth—To furnish printed instructions in the operation and care of our cars.

Sixth—Service to be rendered does not include furnishing repair parts or labor without charge, except as provided in the warranty and in the following specific clauses of this Service Policy.

Replacement of Defective Parts

(a) Within 90 days after delivery of a new car to purchaser the Blank company will furnish, free of charge at the factory, duplicate parts to replace any parts as covered by our warranty that are returned to the factory with shipping charges prepaid and which are determined by the company to have been defective in material or workmanship, or it will put such parts in condition as good as new without charge.

(b) Within 90 days after delivery of a new car to the purchaser the dealer will install, free of labor charges, any parts that the factory furnishes or repairs free of cost to replace any parts determined by the factory to be defective, the purchaser to assume cost of replacement parts and installation of same pending factory decision.

(c) The party returning the parts will be notified promptly of the decision of the factory regarding allowance of a claim for replacement or repair of parts returned.

Inspection and Adjustment

(d) Cars brought to service stations maintained by factory, branch or dealer will be inspected and all necessary adjustments will be made as in paragraphs (e) and (f) without charge during the first month after delivery of a new car to purchaser, provided the car has not been tampered with or injured by accident or neglect. After the first month adjustments will be made at the regular charges of the service station.

(e) Inspection includes examination and report of the condition of the car.

(f) Adjustment includes only such adjustments as inspection has found necessary to put the car in good operating condition.

(g) Every dealer is expected to give the same inspection and adjustment service on the cars made by this company without regard to the territory in which they were bought.

Repairs, Replacements, Etc.

(h) All work not included in inspection and necessary adjustment during the first month, or installation of replacements under the warranty, will be charged for at regular rates.

(i) When any charge work is to be done and the cost can be estimated in advance, the owner, upon request, will be advised of the amount of charges before the work is begun.

(j) When it is necessary, for the convenience of the owner, to render service at a distance from the service station, the time spent by employees going to and from the job will be charged for at the regular rates of the station, together with all proper expenses of making the trip, cost of shipping parts, if any, and other necessary incidental expense.

Overtime Work

(k) Any overtime, holiday or Sunday work done upon the request of the owner will be charged for at the regular overtime rate.

Instructions in Care and Operation

(l) Instructions in printed form regarding the care and operation of the car and its accessories, and proper method of ordering and returning parts, will be given the purchaser upon the delivery of the car.

(m) Personal instruction will be given in accordance with the agreement between dealer and customer at the time of purchase.

General

(n) For service and replacements on engine starters, batteries, magnetos, generators, lamps, carbureters, tires, rims or other trade accessories that are not made by the manufacturer of the car, application may be made direct to the nearest service station maintained by the maker of such accessory. Dealers will be provided with a list giving names and addresses of the manufacturers of said accessories.

(o) No promise of service, free repair work, inspection or adjustment, except as herein specified, given or made by the dealer, shall be binding on the manufacturer of the car.

(p) To help the dealer carry out the intent of this Service Policy, the owner is requested to furnish all information necessary to the prompt and proper filling of orders and issuing of credits and to observe the requirements regarding return of parts with claims for replacement.

(Signed) THE BLANK MOTOR CAR CO.

N. A. C. C. STANDARD REPAIR PARTS POLICY

The purpose of this policy is to place the relations between the Blank Motor Car Co. and its dealers on a definite, fair, uniform and businesslike basis.

1. STOCK OF PARTS—The dealer will be required to maintain a minimum stock of both "current" and "service" parts as specified by manufacturers, to be paid for by the dealer on or before the 20th day of month following delivery.

2. CENSORING OF ORDERS—To prevent the overstocking of inactive parts by the dealer or the purchasing of an excessive stock of any parts, the right is reserved by the manufacturer to reduce in quantity the number of pieces of any part or parts ordered by the dealer.

3. INVENTORIES—The dealer will be required to furnish an inventory of current and service parts upon request. The manufacturer reserves the right to send an auditor to verify inventories and reduce or increase stock as he sees fit in accordance with clause No. 1.

4. SHIPMENTS TO DEALERS' TERRITORY—So far as possible, the dealer will be required to see that all orders for parts from his territory are placed through him.

5. DISCOUNTS—Discounts to garages or repairshops will be at the discretion of the manufacturer.

6.—DESIGNATION OF PARTS STOCKS—Stocks of parts shall be designated as follows:

(a) **Current Parts**—All parts used in cars of models being produced by the factory.

(b) **Service Parts**—All parts for models no longer being produced by the factory and which have not been superseded by other parts that are interchangeable with them.

(c) **Obsolete Parts**—Parts that have been superseded by other parts that are interchangeable with them.

7. RETURN OF PARTS—

(a) **Defective**—Parts claimed defective under the 90-day warranty must be returned to the factory, with shipping charges prepaid, within 30 days from time defect claimed manifests itself.

(b) **Obsolete** parts shall be returned only as ordered by manufacturer.

(c) **Surplus** parts may be returned only by individual arrangement with the manufacturer.

All parts shipped to the manufacturer by dealer shall have transportation charges prepaid and be properly tagged.

8. NOTIFICATION OF OWNER—The manufacturer reserves the right to communicate direct with owners concerning replacement and disposition of parts returned.

9. DISPOSITION OF RETURNED PARTS—The manufacturer reserves the right to dispose, within 30 days, of parts returned without assuming liability unless covered by shipping instructions or adjustment is accepted.

10. PARTS PURCHASED OR MADE OUTSIDE OF TERRITORY—The manufacturer will refuse to consider claims for or accept for adjustment any parts not supplied by him.

(Signed) THE BLANK MOTOR CAR CO.

Definitions of standard truck chassis have been approved by the National Automobile Chamber of Commerce.

The object of these definitions, suggested by Windsor T. White, chairman of the commercial vehicle committee, is to indicate what minimum parts, finish and equipment constitute the standard chassis for gasoline and electric commercial vehicles. The definitions are expected to simplify the compilation of catalog specifications, etc. They read as follows:

WHAT A GASOLINE TRUCK CHASSIS IS

A standard chassis of a commercial vehicle to be propelled by an internal combustion engine shall consist of an assembly of all essential parts of a truck chassis with protective housings, ready for operation on the road, including set of tires attached to wheels; driver's seat with padding or cushion on all chassis rated at 1-ton capacity or more; front wheel fenders; runningboard or mounting step; tool campartment; priming coat of lead on all parts to be painted; pair of front lights and one tail lamp; license brackets; warning signal, jack and a set of tools commonly used for making adjustments and minor repairs on the road.

WHAT AN ELECTRIC TRUCK CHASSIS IS

A standard chassis of a commercial vehicle to be propelled by electricity shall consist of a running gear, motor, battery cradle or box, driving and control mechanism and wiring, with all essential parts, fittings and protective housings thereof, assembled complete ready for operation on the road with the exception of a battery; a priming coat of lead on all parts to be painted; set of tires attached to wheels; pair of front lights and one tail lamp, with necessary wiring installed; license brackets; charging plug and cable; odometer; warning signal, and set of tools commonly used for making adjustments and minor repairs on the road.

Skinner Joins Liberty

DETROIT, MICH., June 9—G. S. Skinner has joined the sales division of the Liberty Motor Car Co. Mr. Skinner has been connected during the past few years with the Canadian distributors of the Hudson company.

Brunning and Benedict Join Oakes

INDIANAPOLIS, IND., June 8—W. H. Brunning and H. M. Benedict have joined the engineering department of the Oakes Co., this city.

French Import Ban in Effect

Barring of American Automobiles, Bodies and Chassis Affects Dealers

PARIS, June 3—On the ground that shipping was required for articles of greater national importance, the French Government has prohibited the importation of automobiles, automobile bodies and automobile chassis. Other articles barred in the same decree comprise such luxuries as pictures, photographs, jewelry, cameras, etc. Within 48 hr. of the law being passed, the decree had been signed putting prohibition into force. This rapid action came as a surprise to some dealers who were ill prepared for it. It was obvious, however, after England's action in imposing first a 33 1/3 per cent duty then prohibition that France would not be long in following suit. Careful observers were aware, too, that the French automobile industry was doing its best to influence the government toward prohibition of automobile imports.

Must Close Agencies

All the agents affected are handling American cars, the makes of cars being Ford, Overland, Buick, Dodge, Maxwell, Chevrolet and Saxon. These were the only ones doing active business in France. Generally sufficient stocks are held to keep business going for a couple of months. After that the agencies may as well close, for they will have nothing more to sell. Although the law is in force, an attempt is being made by dealers to get it repealed. It is pointed out that the demand for cars comes from persons who need automobiles in their business. This is shown by the fact that as soon as French cars are requisitioned by the military American cars are bought in place of them. These purchases would not be made at the present time if the cars were not really necessary. By shutting out American cars at a time when the home factories are unable to supply, dealers will be ruined and their business connections lost. Thus the French manufacturers are doing themselves harm, for they are destroying businesses which are essential to their prosperity in normal times.

It is very doubtful if the protest against prohibition will produce any immediate result. The influential leading manufacturers are enraged at the possibility of America getting hold of the French market, and will bring very strong pressure to bear against any attempt at repeal. It is obvious too, that when this protective measure becomes unnecessary at the end of the war, they will not be satisfied to return to their old tariff rate, but will ask for a substantial increase.

Much of the opposition is directed against Ford; yet it is significant that Ford is now building a big factory in England and in the future will supply the Continental market from that source. Thus any preferential tariff among the Allied powers will necessarily admit Ford into the French market on the same terms as cars of entirely English origin. Some members of the industry are inclined to look upon the Ford as a missionary car which will extend the motoring movement. The majority, however, look upon it as a direct competitor.

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White Domestic Orders Gain 45 Per Cent in 4 Months

CLEVELAND, OHIO, June 9—Domestic orders of the White Motor Co., this city, have gained 45 per cent during the first four months of 1916. It is reported that 4000 White trucks are being used by the Russian army and that further orders from that country are expected. At the French army's headquarters, 1000 White trucks are held for emergency service, so that not less than 5000 White trucks are in use by the Allied army.

As of Dec. 31, the company's buildings, machinery and current assets amounted to $12,537,275, and total liabilities other than capital stock amounted to $2,013,120, leaving a balance of $10,524,155 in net tangible assets, which is equivalent to 66 per cent on the capital stock.

The net profits for 1915 were $8,700,000, equal to 54.3 per cent on the $18,000,000 stock, and the output was 8100 cars.

The company recently received an order for 800 trucks from the French government, and it is stated that negotiations are now pending for the purchase of 500 more from that company.

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465 Packards Shipped to Allies

NEW YORK CITY, June 14—The first trainload of ten will arrive in the freight yards of the Pennsylvania Railroad this week loaded with one of the largest shipments of trucks ever made in this country. The entire shipment consists of 465 Packard trucks, valued at $2,000,000, purchased by Gaston, Williams & Wigmore, for immediate shipment to Russia, England and France. As only two trucks can be loaded to a car, the shipment will consist of 233 specially built freight cars.

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Evans with United Truck

GRAND RAPIDS, MICH., June 13—E. C. Evans, formerly with the Packard Motor Car Co., Detroit, has been appointed production manager of the United Motor Truck Co.

Monster Merger Is Abandoned

Complications Arise Causing Entire Plan of $250,000,000 Combine to Be Dropped

NEW YORK CITY, June 14—Quite unexpectedly comes official announcement from John N. Willys, that owing to the failure of the parties concerned in the $250,000,000 merger to come to a definite agreement, the plan has been abandoned. Rumors have up to this time been coming from Wall Street of a hitch in negotiations, but details were not available.

During the latter part of last week an official statement from Mr. Willys had it that a new corporation was to be organized by him and associates in the Willys-Overland Co., which would acquire their holdings of the stock of that company and the entire capital stock of the Auto-Lite Co. The new corporation was to be controlled by Mr. Willys. Among the properties under consideration were those of the Hudson, Chalmers and Fisk companies.

These companies will continue to act independently. It is understood that there were legal difficulties which it was feared might lead to serious complications.

It is stated that the bankers sought to impose certain obligations which the manufacturers refused to adopt and *vice versa*.

In well informed circles attention was drawn to the fact that since the first announcement of the proposed formation of the new concern there has been no definite statement issued as to the capitalization or the basis of stock exchange on which the different companies reported were to be taken over. In spite of this fact an underwriting syndicate composed of William Salomon & Co., J. S. Bache & Co., Dominick & Dominick and Laird & Co. of Wilmington, Del., had been formed.

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Corcoran Mfg. Co. Formed

CINCINNATI, OHIO, June 12—Corcoran interests are represented in a new company to manufacture fenders, hoods and radiators for automobiles. Three of the five Corcoran brothers, who were in the recent merger of the Corcoran Lamp Co., the Victor Lamp Co. and the Victor Auto Parts Co., into the Corcoran-Victor Co., are represented in the new concern. They are John J., E. B. and William J. The first-named is president, E. B. Corcoran is vice-president, and William J. is treasurer. W. R. Hughes, formerly sales-manager of the Victor Auto Parts Co., is secretary and sales manager of the new company.

The company expects to be turning out 500 sets of fenders on or about July 1.

Lower Gasoline Prices Predicted

Federal Trade Commission Told of Coming Overproduction at 2-Day Hearing

WASHINGTON, D. C., June 13—Predictions of lower gasoline prices in the near future were made at the hearing before the Federal Trade Commission to-day, because of the recent discovery of oil fields, which, it was contended, will cause overproduction. T. J. James, secretary of the Assn. of Refiners of Kansas and Oklahoma, responsible for this statement, also exonerated the Standard Oil Co. from the charge of putting up the price, and said the upward tendency was wholly natural under the conditions of the oil market. At the time of the rise in price, he said, the Standard Oil Co. held probably 51 per cent of the production properties, but now he thought that the independents held about that proportion of the crude output.

At yesterday's meeting it was charged that the big companies originally started the increase in the price of gasoline through manipulation and through speculating in crude petroleum. It was also brought out, in answer to the preceding charges, that the big companies bought up crude petroleum not for speculation but because experts predicted a famine and the companies were seeking merely to protect themselves.

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To Make P. D. Q. Spark Plug

DETROIT, MICH., June 10.—The Wolverine Spark Plug Co., a newly incorporated concern, with a capital of $100,000, has located at 45 Fort Street, East, in the Boydell Building. New equipment is now being installed to manufacture in large quantities a new spark plug called the P. D. Q.

The officers and directors of the company include C. H. Braselton, president; A. Kugeman, vice-president, and P. S. Linton, secretary and treasurer; also F. R. Pence and William Bohleber.

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Ludwig Opel Killed at Verdun

NEW YORK CITY, June 9—According to advices from Copenhagen the well-known German automobile manufacturer, Ludwig Opel, was killed at Verdun in May.

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3,000,000 Edmunds & Jones Lamps for 1916 Season

DETROIT, MICH., June 8—The Edmunds & Jones Corp., this city, will produce 3,000,000 lamps in the current year and arrangements are being made to handle an output of 4,000,000 lamps in 1917. The output in 1915 was 1,467,119 lamps, in 1914 it was 661,430 and in 1913, 442,646.

The company has $500,000 in cash and gross sales this year are expected to exceed $4,000,000, and net after preferred dividends, of about $15 a share on the 40,000 shares of common stock.

The Detroit plant is now turning out 20,000 lamps daily compared with 16,000 in 1915.

An addition will be made to its Chicago Electric Mfg. Co. plant which will double its output.

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Hancock Represents Dort in Antipodes

FLINT, MICH., June 8.—R. J. Hancock, proprietor of the Colonial Trading Co., Melbourne, Australia, has been appointed direct factory representative of the Dort Motor Car Co. in Australia and New Zealand.

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Batchelder Joins Dort Sales

FLINT, MICH., June 8.—C. F. Batchelder, for many years sales manager of the John Deere Plow Co., St. Louis, Mo., has become assistant general sales manager of the Dort Motor Car Co., this city.

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Smith Is Argo Sales Director

JACKSON, MICH., June 8—W. L. Smith of the Smith Motor Sales Co., Washington, D. C., has been appointed director of sales for the Argo Motor Co., Inc. Mr. Smith has been the Argo distributor in the East and South since the first car was put on the market.

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Hilts Joins Puritan Machine

DETROIT, MICH., June 12.—The Puritan Machine Co., Detroit, has appointed M. R. Hilts as assistant to Frank M. Eldridge, advertising manager, appointment to take place immediately. Mr. Hilts was formerly connected with the advertising department of the Oakland Motor Car Co., and of the Paige-Detroit Motor Co.

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Morehead Heads N. Y. Goodrich Branch

NEW YORK CITY, June 9.—H. J. Morehead has been appointed manager of the local branch of the B. F. Goodrich Co. Mr. Morehead entered the service of this company in 1905 at its Detroit branch as a salesman. In 1908 he succeeded H. C. Miller as manager there.

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Durst Is Delco Publicity Mgr.

DAYTON, OHIO, June 10.—J. E. Durst has succeeded W. O. Waldsmith as publicity manager of the Dayton Engineering Laboratories Co., this city.

Mr. Waldsmith will be general agent for the Delco-Light, the new farm lighting plant. His territory includes the Eastern half of Missouri and about fifteen counties in Illinois.

Gasoline at 11 Cents a Gal.

Rittman Process Enables Production at That Price with Use of Oil Residue

NEW YORK CITY, June 12.—Gasoline may be produced for about 11 cents per gal. by the Rittman process when fuel oil sells for about $1.40 per barrel, the average current price. This oil is the residue from the crude, after the gasoline and kerosene have been subtracted from it. Its price varies throughout the country, averaging at the present time $1.20 to $1.30 in Chicago, and $1.50 to $1.60 in New York. At $1.20 the price is 10 cents and at $1.60, 12 cents. With oil at 50 cents per barrel the cost would drop to 7.8 and with oil at $2.10, the price would be 13.9 cents. These figures are for a $20,000 plant which would have a monthly capacity of about 5000 barrels. Seventeen per cent of the fuel oil becomes gasoline, 10 per cent is lost in the process, and 73 per cent remains fuel oil and may be sold at the same figure at which it was purchased.

COST OF FUEL OIL 50 CENTS PER BBL.

Expense

5000 bbl. fuel oil at 50c. per bbl.		$2,500
Production cost—		
Labor for 1 month	$560	
Fuel (1050 M feet at 15c.)	160	
Electricity	100	
Repairs	100	
Interest and depreciation, 6 per cent each	200	
Refining cost, 20c. per bbl.	1,000	
Production cost	$2,120	2,120
		$4,620

Credit

3650 bbl. residuum at 50c. (fuel oil)	1,825

Net Cost

Net cost 850 bbl. (35,700 gal.) gasoline. $2,795
Cost of gasoline per gallon, 7.8 cents.

COST OF FUEL OIL $1 PER BBL.

Expense

5000 bbl. oil at $1	$5,000
Production cost	2,120
Total cost	$7,120

Credit

3650 bbl. residuum at $1 (fuel oil)	$3,650

Net Cost

Net cost 850 bbl. (35,700 gal.) gasoline. $3.470
Cost of gasoline per gallon, 9.74 cents.

COST OF FUEL OIL $1.47 PER BBL.

Expense

5000 bbl. oil at $1.47	$7,350
Production cost	2,120
Total cost	$9,470

Credit

3650 bbl. residuum at $1.47 (fuel oil)	$5,365

Net Cost

Net cost 850 bbl. (35,700 gal.) gasoline. $4,105
Cost of gasoline per gallon, 11.5 cents.

COST OF FUEL OIL $2.10 PER BBL.

Expense

5000 bbl. oil at $2.10	$10,500
Production cost	2,120
Total cost	$12,620

Credit

3650 bbl. residuum at $2.10 (fuel oil)	$7,665

Net Cost

Net cost 850 bbl. (35,700 gal.) gasoline. $4,955
Cost of gasoline per gallon, 13.9 cents.

Houk To Increase Production

Completes New Sheet Metal Stamping Plant—Large Scale Operations Start Sept. 1

BUFFALO, N. Y., June 12. — With the addition of a new sheet metal stamping plant and the installation of Bliss presses, the Houk Mfg. Co., this city, will be on a larger scale of production by Sept. 1. This addition will provide a production of 5000 hub shells per day besides its own production of 50,000 spokes per day.

A contract has been placed with the Standard company of Torrington, Conn., for a minimum of 1,000,000 spokes per month beginning Sept. 1. Arrangements have been made in Detroit and Chicago for factories to assemble a minimum of 1000 wire wheels per day.

Ford Tractor Plants in Foreign Countries

DETROIT, MICH., June 10—Gaston Plaintiff, New York manager of the Ford Motor Co., sailed last week on the Scandinavian-American liner Frederick VIII for a general tour of investigation of all countries of Europe. Mr. Plaintiff will lay the lines for an investment of many millions of dollars, perhaps eventually $25,000,000 in manufacturing plants for the Ford tractor.

General charge of the European tractor business is to be vested in Mr. Plaintiff, who will ultimately establish permanent headquarters in one of the foreign capitals. R. S. Neely accompanied Mr. Plaintiff.

The first purchase of land will be in Norway, Sweden or Denmark to supply those three countries. Thereafter Holland, England, France, Germany and Russia will be visited.

The latter country will be toured extensively.

Essex Motor Truck Co. Formed

NEW YORK CITY, June 8.—J. T. Rainier and P. N. Lineberger, who have been associated in the automobile business in this city since 1901 as Eastern distributors for passenger cars and commercial vehicles, have organized the Essex Motor Truck Co., with a capital of $600,000.

The company will produce only one model, a 1000-lb. truck, the chassis of which will retail for about $750. It will be composed of standard units, including Timken worm drive in the rear axle, a Light 3¼ by 4½-in. motor, rated at 16.9 hp.

Among the stockholders and directors are Gottfried Piel and William Piel of Piel Bros., brewers; C. W. Feigenspan, president of the Feigenspan Brewing Co. and of the Federal Trust Co., Newark, also Adolf Kuttroff and Carl Pickhardt, both of the Badische Co., importers of dyes and chemicals. The engineering and designing will be in charge of Carl Neracher, formerly chief engineer of the Willys-Overland and Garford companies.

The offices of the company are at present located at 299 Madison Avenue, this city, pending the completion of a factory in Long Island City.

Emerson Four at $395

NEW YORK CITY, June 9.—The Emerson Motors Co., recently incorporated with offices in this city at 1328 Broadway, announces a five-passenger four-cylinder car, selling at $395, f.o.b. New York.

The specifications include a 3¾ by 4-in. block motor, thermo-syphon cooling, selective three-speed gearbox in unit with the motor, multiple disk clutch, center control, rack and pinion steering gear on left, floating rear axle, forged I-beam front axle, 30 by 3-in. front tires and 31 by 3½-in. rear, pressed steel frame, semi-elliptic front springs, 110-in. wheelbase, steamline body, one-man top, 10-gal. gasoline tank, crowned fenders, two head lamps and one tail, electric horn and complete tool kit.

Lancaster Wiregrip Tire Litigation Brought to an End

LANCASTER, OHIO, June 8.—Announcement has been made by the Lancaster Tire & Rubber Co., Lancaster, Ohio, manufacturer of Wiregrip pneumatic tires, that patent litigation, which practically took the original wire tread tires formerly manufactured in Hartford, Conn., off the market, has all been satisfactorily concluded. In the future these tires will be known and marketed as the Wiregrip, with headquarters at Lancaster, where they will be manufactured on a large scale.

The Wiregrip differs from other makes in that it has imbedded in its tread to a great depth four endless triangular coils of spring steel. A little wear develops hundreds of little steel prongs which serve the purpose of holding to the road with a vice-like grip, thus preventing skidding on wet or slippery streets.

Blair Resigns from S. K. F. to Form Own Company

HARTFORD, CONN., June 8. — F. R. Blair, formerly secretary, treasurer and sales manager of the S. K. F. Ball Bearing Co., has resigned and has become president of F. R. Blair & Co., with offices at 50 Church Street, New York City. It is understood that Mr. Blair is engaged in developing motor efficiency devices.

Motometer Secures New Plant

Boyce Organization Will Start Manufacturing in L. I. City Factory July 1

NEW YORK CITY, June 9—With standard equipment on forty makes of cars and with business increasing each day, the Motometer Co., this city, maker of the Boyce Motometer, a motor heat indicator, has been forced to find larger factory quarters. A large three-story plant in the center of the automobile district in Long Island City has been taken and manufacturing will be started in it about July 1.

The new plant will put the company on a larger scale of production, about triple the present, and the floor space will be increased five times the present, about 20,000 sq. ft.

The local plant will not be given up, operations in it being confined to light assembly work.

Bell Purchases Factory

YORK, PA., June 9.—The Bell Motor Car Co., which was organized in this city less than a year ago for the purpose of manufacturing automobiles, has increased its capitalization to $1,000,000.

It has just purchased a 15-acre factory site in East York at Rockburn Station, upon which it proposes to erect, between now and the first of next year, modern factory buildings.

This firm has been placing upon the market this season two models—a pleasure car and a light 1000-lb. commercial car.

As soon as the new factory buildings are completed this concern expects to be able to provide employment for 500 to 1000 men.

Lauterbach To Build Cars

NEW YORK CITY, June 13.—H. Lauterbach, manager of sales for the New York branch of the Chevrolet Motor Co., has resigned to enter the manufacturing field. With others he has purchased the plant of a manufacturer in the Central West and will market a passenger car and a light delivery vehicle to sell for about $700.

Gundrum Joins Bell

YORK, PA., June 9.—H. F. Gundrum of York, formerly connected with the traffic department of the Pullman Motor Car Co., has been made traffic manager of the Bell Motor Car Co. Prior to his going with the Pullman company he was the agent for the Western Maryland Railway Company in York.

April Exports Total $11,692,945

1790 Trucks, Value $5,294,801; 6242 Cars at $4,998,350—Parts at $1,399,794

WASHINGTON, D. C., June 10—American makers of trucks, pleasure cars and parts continue to expand in foreign fields, according to official figures compiled by the statistical bureau of the Department of Commerce. In April last the number of trucks exported was 1790, valued at $5,294,801, while the passenger car exports totaled 6242 machines, the value of which was $4,998,350. The exports of parts, not including engines and tires, were valued at $1,399,794. For the 9 months' period ended April, 1916, the exports reached these tremendous totals: Commercial cars, 18,135, valued at $48,898,380; passenger cars, 45,048, valued at $34,269,158; parts, not including engines and tires, $18,223,401.

Turning to the figures for last year it is found that during April a year ago 2267 commercial cars, valued at $5,240,481; 3078 passenger cars, valued at $2,804,741, and $1,807,567 in parts, not including engines and tires, were shipped abroad, while during the 9 months' period of 1915 the figures were: Commercial cars, 8580, valued at $23,977,968; passenger cars, 14,641, valued at $12,356,472; parts, $5,258,175.

While the warring nations of Europe, with the exception of Germany, continue as heavy buyers of American-built motor cars, it is interesting to note that countries like South America and the British possessions in Oceania are constantly growing in importance as markets for our cars.

In April last France imported 1056 cars, valued at $3,086,601, from this country, while in April a year ago the number was just one less, but the value was only $1,710,702. The exports to France during the 9 months' period increased from 3951 cars, valued at $10,035,842, in 1915, to 6203 cars, valued at $16,290,264, in 1916.

Russia's purchases of American cars in April last amounted to 178 machines, valued at $433,825, while during the 9 months' period of 1916 the number was 4774 and the value $14,868,354. Russia did not figure in the export returns last year, so there are no comparative figures available.

Germany did not import any American machines in April of this and last year, but during the 9 months of 1915 the returns show that twenty cars, valued at $20,164 were shipped there.

Seven hundred and thirteen cars, valued at $870,184, was the United Kingdom's contribution to American motor car makers in April last, which is a decline from last year's figures for the same period, which were 1455 cars valued at $1,925,280. However, during the 9 months' period the exports there rose from 7652 cars, valued at $10,840,309, in 1915, to 16,820 cars, valued at $22,959,602, in 1916.

There were seventy-three cars, valued at $55,452, shipped to Denmark in April last, while during the 9 months of this year the number was 597 and the value $411,708. No comparative figures for these periods of last year are available.

Italy's share in our automobile export trade in April last was only 4 cars, valued at $3,073, as against 23 cars, valued at $9,983, in April a year ago. During the 9 months' period the exports there increased from 88 cars, valued at $58,368, in 1915, to 256 cars, valued at $172,731, in 1916.

"Other Europe" imported 395 cars, valued at $922,988 in April last, as against 855 cars, valued at $2,535,169, in April a year ago, while the shipments for the 9 months' period fell from 2118 cars, valued at $6,129,392, in 1915, to 1745 cars, valued at $2,259,142, in 1916.

On this side of the Atlantic the figures show that Canada contributed largely to our export trade during the periods under consideration, the exports in April last totaling 2130 cars, valued at $1,371,108, as against 696 cars, valued at $611,797 in April a year ago. During the 9 months' period the exports to the Dominion increased from 2768 cars, valued at $3,165,739 cars, in 1915, to 7433 cars, valued at $5,156,373, in 1916.

Large Demand from South America

A striking feature of the automobile export trade is the constantly increasing demand for American cars in South American countries. Formerly the department grouped all the automobile exports to South America under one head and last year's returns show that 98 cars, valued at $60,437 were shipped there in April, while during the 9 months' period the number was 906 cars, and the value $494,488. In April last Argentina alone imported 505 cars from this country, the value of which was $245,984, while during the 9 months of this year the shipments amounted to 3497 cars, valued at $1,630,943. Chile bought 125 cars from us in April last, the value being $86,814, while during the 9 months' period the number was 704 cars, and the value $464,555. Only 20 cars, valued at $12,318 were shipped to Brazil in April last, but during the 9 months of this year the number reached 204 cars, valued at $127,247. Venezuela's contribution was 47 cars, valued at $24,718, in April, and 416 cars, valued at $264,470, during the 9 months of this year, while all other South American countries purchased 40 cars, valued at $21,419, in April, and 453 cars, valued at $256,288 during the 9 months' period.

Exports of Automobiles, Trucks and Parts for April and 10 Previous Months

	April				10 Months Ending April			
	1915		1916		1915		1916	
	Number	Value	Number	Value	Number	Value	Number	Value
Passenger cars	3,078	$2,804,741	6,242	$4,998,350	14,641	$12,356,472	45,048	$34,269,158
Commercial cars	2,267	5,240,481	1,790	5,294,801	8,580	23,977,968	18,135	48,898,380
Parts, not including engines and tires	.....	1,807,567	.....	1,399,794	.....	5,924,175	.....	18,223,401
	5,345	$9,852,789	8,032	$11,692,945	23,221	$42,258,615	63,183	$101,390,939
By Countries								
Denmark	.....	.....	73	$55,452	.....	.....	597	$411,708
France	1,055	$1,710,702	1,056	3,086,601	3,951	$10,035,842	6,203	16,290,264
Germany	.....	.....	.....	.....	20	20,164	.....	.....
Italy	23	9,983	4	3,073	88	58,368	256	172,731
Russia	.....	.....	178	433,825	.....	.....	4,774	14,868,354
United Kingdom	1,455	1,925,280	713	870,184	7,652	10,840,309	16,820	22,959,602
Other Europe	855	2,535,169	395	922,988	2,118	6,129,392	1,745	2,259,142
Canada	696	611,797	2,130	1,371,108	2,768	3,165,739	7,433	5,156,373
Mexico	6	4,025	47	43,897	64	63,660	338	328,318
West Indies and Bermuda	247	119,893	497	272,099	1,121	696,210	3,860	2,345,668
South America	98	60,437	.....	.....	906	494,488	.....	.....
Argentina	.....	.....	505	245,984	.....	.....	3,497	1,630,943
Brazil	.....	.....	20	12,318	.....	.....	204	127,247
Chile	.....	.....	125	63,814	.....	.....	704	464,555
Venezuela	.....	.....	47	24,718	.....	.....	416	264,470
Other South America	.....	.....	40	21,419	.....	.....	453	256,288
British East Indies	.....	.....	341	268,987	.....	.....	2,467	1,875,183
British Oceania	307	270,230	1,319	948,367	2,471	2,059,033	6,109	5,000,813
Asia and other Oceania	394	560,845	181	280,498	1,340	2,119,888	4,178	5,461,385
Other countries	209	236,861	361	1,332,498	722	651,347	3,129	3,294,494
	5,345	$8,045,222	8,032	$10,257,830	23,221	$36,334,440	63,183	$83,167,538

Resta and De Palma Matched

To Meet June 18 on Chicago Speedway in Three Heats—$5,000 Prize Offered

CHICAGO, ILL., June 13—Resta in his Peugeot and De Palma in his Mercedes, first and second in Sunday's 300-mile race on the Chicago speedway, have agreed to a match race to take place on the local track Sunday, June 18. They will race to determine which driver and which car is supreme, as the claim has been current that Resta's winning was a matter of luck and that De Palma's Mercedes is a faster car. Arrangements call for a series of three heats, one of 10 miles, one of 24 miles and a third of 50 miles, the two best out of three declares the winner. A prize of $5,000 has been offered by the speedway management, and A. A. A. sanction is already filed.

Neither of the drivers wishes it to be understood that this is a challenge race. De Palma wants to show his friends who have claimed that his traditional hoodoo lost the race that their assumptions are justified, and Resta's plans are to give proof that the race was won because he drove his blue Peugeot faster than any other pilot and could have done even more. According to the statements of both drivers the agreement was reached when the ten prize winners appeared yesterday at the speedway office for their checks.

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250-Mile Speedway Race for Arizona

PHOENIX, ARIZ., June 10—A 250-mile automobile race over a three-mile speedway will be the principal event of the Arizona State Fair. It will be staged on the afternoon of Saturday, Nov. 18, the last day of the fair.

This plan, originated by Secretary Tom Shaughnessy, has been approved by the fair commission, which has set aside $7,500 for prizes. Steps have been taken to secure a sanction from the A. A. A., the idea of holding outlaw races having been dropped.

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1917 Velie Six-Cylinder Cloverleaf Roadster Added to Line

MOLINE, ILL., June 9.—The Velie Motor Vehicle Co., this city, has announced for 1917 its model 22, a cloverleaf roadster, seating four, at $1,065. The chassis remains the same as the 1916 model, the only changes being in the body. A 40-hp. Continental motor is used. Other features include: multiple dry disk clutch, automatic ignition, Hotchkiss drive, special gears in rear axle, 50-in. underslung rear springs, Stewart vacuum feed, two-unit Remy electric system, deep tufted upholstery, double bulb headlights, 15-gal. gasoline tank with gage, one-man top, 32¼-in. tires, with non-skids in the rear.

The top furnished is made to fold down closely around the outside of the backs of the rear seat, and the dust cover, when in position, is closed over the two rear seats, making them invisible. This arrangement gives the car the appearance of a two-passenger roadster with an ordinary top cover on.

This roadster has unusually large space for luggage aside from the space in rear and under the seats. There is a compartment back of the front seats with doors opening from the inside; these doors are padded on the top and act as a rest for the arms of those sitting in the rear seats.

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Two Wheelbases for 1917 Chalmers

DETROIT, MICH., June 12.—For 1917 the 3400 r.p.m. Chalmers will be made in two wheelbase lengths, 115 and 122 in., the latter being for seven-passenger bodies—the touring model will sell for $1,280. The wheelbase of the five-passenger will remain at 115 and the price at $1,050 for the open model; roadster and cabriolet models will be made as heretofore. On the larger chassis will be mounted three closed body designs, a touring sedan, limousine and town car. All three seat seven.

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Vanderbeck Leaves Timken Bearing

DETROIT, MICH., June 8—H. Vanderbeck, chief engineer of the Timken Roller Bearing Co., Canton, Ohio, will sever his connection with this company in the near future. His successor has not yet been selected.

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Allen Enlarges Bucyrus Plant

FOSTORIA, OHIO, June 9.—The Allen Motor Co. has broken ground for an addition to its motor and transmission plant in Bucyrus. The addition will double the size of the plant.

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Reynolds with Paige-Detroit

DETROIT, MICH., June 9—F. H. Reynolds, Jr., has joined the Paige-Detriot Motor Car Co., this city, in the capacity of special representative. Reynolds comes from the Champion Ignition Co., Flint, Mich.

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Ask Receiver for Lauth-Juergens

FREMONT, OHIO, June 9—A receiver for the Lauth-Juergens Motor Car Co., is asked in a suit filed recently to obtain judgment of $526.74 for labor and material. Recently stockholders of the company voted to transfer the company to the H. G. Burford Co.

Studebaker Convention Closes

Demand for Cars Expected to Last Throughout Year—8000 Cars a Month

DETROIT, MICH., June 10.—That the present unprecedented demand for automobiles will continue throughout the year instead of showing the customary slack during the summer and fall months was the message brought by Studebaker branch managers who attended the semi-annual branch managers' convention of the Studebaker Corp. in Detroit June 6-9. The predictions made by the branch managers were based on a study of conditions in their territories. Heads of the Studebaker branches in all parts of the country were present at the sessions during the week, as were also the assistant branch managers, district managers and retail sales managers.

Orders now on hand, the nation's prosperity and the fast swelling ranks of people who recognize the motor car as a utility and in many cases a necessity rather than an expensive luxury—these were given as the chief reasons for the prospect of a continuing demand of even larger proportion than ever before known.

According to J. G. Heaslet, vice-president, in charge of engineering and production, factory additions and enlargements of facilities will soon make possible a normal output of 8000 cars a month and a forced output of 10,000. July 1, despite the materials situation, it was announced, will show shipments for the preceding 12 months of more than 65,000 cars, which is approximately double the best previous year.

L. J. Ollier, vice-president and director of sales, who presided at the various sessions at the convention, announced that the Studebaker dealer organization has grown in 2 years from 2000 to 6500.

The opening day was occupied with group conferences with the sales officials, followed by tours through several of the plants, where an opportunity was afforded to see the additions that have been made since the last convention in December.

In addition to Messrs Erskine, Ollier and Heaslet, talks were made by C. C. Hanch, treasurer; C. D. Fleming, assistant treasurer; H. E. Dalton, general auditor; R. T. Hodgkins, general sales manager; G. L. Willman and W. T. Bush, assistant general sales managers; H. T. Myers, commercial car sales manager; H. A. Biggs, advertising counsel; Max Hagelstine, service manager; C. L. Hemphill, secretary of the Commercial Investment Trust Co. of New York, and Walter Robbins, vice-president of the Wagner Electric Co. of St. Louis.

Clifton Heads N. A. C. C. for 1917

Shipments for Year Amount to 237,523 Carloads—Eleven New Members

NEW YORK CITY, June 9—Charles Clifton, treasurer of the Pierce-Arrow Motor Car Co., Buffalo, N. Y., was re-elected president of the National Automobile Chamber of Commerce, Inc., at the annual meeting held here yesterday, which was characterized by a record attendance of members of the chamber. The other officers were all re-elected, as follows: First vice-president, W. C. Leland, vice-president and manager of the Cadillac Motor Car Co., Detroit; second vice-presidents, Hugh Chalmers, (gasoline passenger car division), president Chalmers Motor Co., Detroit; Windsor T. White (commercial vehicle division), president of the White Co., Cleveland, and H. H. Rice (electric vehicle division), president of the Waverley Co.; secretary, R. D. Chapin, president of the Hudson Motor Car Co., Detroit; treasurer, George Pope, receiver Pope Mfg. Co., and general manager, Alfred Reeves.

The directors elected were J. N. Willys, president of the Willys-Overland Co., Toledo, Ohio; C. C. Hanch, treasurer of the Studebaker Corp.; H. H. Rice, Waverley, and J. Walter Drake, president of the Hupp Motor Car Co., Detroit.

Oppose Tavenner Bill

The automobile makers placed themselves on record as opposed to the Tavenner bill now before Congress, which has for its purpose the prohibition of the use of time studies and premium or bonus payments in connection with work of the government. The makers feel that such a bill or any similar measure is dangerous class legislation which would prevent efficient methods in private manufacturing industries and be directly opposed to the interests of the whole population of the country and to the working men themselves, by placing a premium on inefficiency besides reducing the production capacity of manufacturing plants.

There are now ninety-seven companies holding membership in the N. A. C. C., eleven of which were admitted since last June, including the Argo Motor Co.; Consolidated Car Co.; Denby Motor Truck Co.; Dort Motor Car Co.; Empire Automobile Co.; Grant Motor Car Corp.; International Harvester Corp.; Lewis Spring & Axle Co.; Milburn Wagon Co.; Monroe Motor Co.; and the Mutual Motors Co.

Shipments Gain

Substantial gains in automobile shipments for the month of May were reported by the Traffic Committee, as stated in THE AUTOMOBILE for June 8, the figures showing that more than 24,000 carloads were as against 15,392 carloads for the month of May last year. The shipping conditions have become more normal and makers are no longer obliged to use flat cars in shipping automobiles.

During the year the shipment of 237,523 carloads of automobiles was made and 9523 notices were sent to the railroads in advance of the arrival of shipments, so as to insure prompt return of freight cars to manufacturing territory.

The commercial vehicle convention decided that no truck show was necessary at this time. They decided against any change in the standardization of frame widths at this time.

For the protection of buyers of trucks, a standard definition for motor truck chassis, both gasoline and electric, was decided upon and the convention, together with the annual meeting, approved a form of service policy which is expected to supply even better service to the truck owner.

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Now O-So-Ezy Products Co.

DETROIT, MICH., June 10.—The O-So-Ezy Mop Co. has changed its name to O-So-Ezy Products Co.

Daily Market Reports for the Past Week

Material	Tues.	Wed.	Thur.	Fri.	Sat.	Mon.	Week's Ch'ge
Aluminum, lb.	.58	.58	.58	.58	.58	.58	...
Antimony, lb.	.23½	.22¾	.21½	.21½	.21½	.21½	—.02
Beams & Channels, 100 lb.	2.77	2.77	2.67	2.67	2.67	2.67	—.10
Bessemer Steel, ton	45.00	45.00	45.00	45.00	45.00	45.00	...
Copper, Elec., lb.	.28	.28	.28	.28	.28	.28	...
Copper, Lake, lb.	.28	.28	.28	.28	.28	.28	...
Cottonseed Oil, bbl.	10.85	11.02	10.85	10.75	10.75	10.80	—.05
Fish Oil, Menhaden, Brown, gal.	.55	.55	.55	.55	.55	.55	...
Gasoline, Auto, bbl.	.24	.24	.24	.24	.24	.24	...
Lard Oil, prime, gal.	1.05	1.05	1.05	1.05	1.05	1.05	...
Lead, 100 lb.	6.95	6.95	6.90	6.85	6.85	6.80	—.15
Linseed Oil, gal.	.68	.68	.68	.65	.65	.66	—.02
Open-Hearth Steel, ton	42.00	42.00	42.00	42.00	42.00	42.00	...
Petroleum, bbl., Kans., crude, gal.	1.55	1.55	1.55	1.55	1.55	1.55	...
Petroleum, bbl., Pa., crude, gal.	2.60	2.60	2.60	2.60	2.60	2.60	...
Rapeseed Oil, refined, gal.	1.05	1.05	1.05	1.05	1.05	1.05	...
Rubber, Fine Up-River, Para, lb.	.66	.66	.65	.65	.64	.64	—.02
Rubber, Ceylon, First Latex, lb.	.70	.70	.70	.70	.70	.64	—.06
Sulphuric Acid, 60 Baume, 100 lb.	3.00	3.00	3.00	3.00	3.00	3.00	...
Tin, 100 lb.	44.50	44.50	45.25	44.50	44.50	44.25	—.25
Tire Scrap, lb	.05¾	.05¾	.05¾	.05¾	.05¾	.05¾	...

Hanlon Patent Invalid

Injunction Against N. A. C. C. Members on Use of Windshield to Be Lifted

CINCINNATI, OHIO, June 9—The United States circuit court of appeals for the sixth circuit has declared the Hanlon windshield patent invalid and will later lift the injunction against the National Automobile Chamber of Commerce members, after certain technical formalities have been observed. Until that time, the members will continue to respect the injunction.

The case in question is particularly important in that many manufacturers are using the Hanlon idea of windshield, which is a double glass with the outer or forward glass divided and the top adjustable so that it can be inclined forward to serve as a rain vizor if necessary.

The decisions just handed down involve the cases of Rauch & Lang Carriage Co., against William B. Hanlon and J. R. Wardrop and the Anderson Electric Car Co., and the National Automobile Chamber of Commerce, Inc., against William B. Hanlon and James R. Wardrop and the Anderson Electric Car Co.

These cases are separate appeals from the decision of the United States district court, northern district of Ohio, eastern division, in which the court held the Hanlon reissue patent No. 13,653, Dec. 2, 1913, valid and infringed and ordered an injunction against the Rauch & Lang Carriage Co. and the National Automobile Chamber of Commerce and its members.

The N. A. C. C. took a separate appeal in which it denied the legality of including the chamber and its members in the injunction. The decisions of the circuit court of appeals in reversing the lower court will cause the dissolution of the injunction against the chamber and its members and also the Rauch & Lang Carriage Co.

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Market Prices Steady

NEW YORK CITY, June 13—Automobile material prices were steady last week. Those changes that occurred were drops caused by dull markets. Lead, which was weak and dull, dropped 15 points to $6.80 per 100 lb., and tin, which was in a similar condition, was 25 cents lower, closing yesterday at $44.25 per 100 lb. Copper remained unchanged at 28 cents a pound, with a quiet market.

Crude rubber was steady though lower in price. Fine up-river Para declined to 64 cents a pound, at a loss of 2 cents.

Yesterday Ceylon grade was more active with quotations at 64 cents a pound. The domestic demand is quiet. The arrivals in London last week were light, but the landings have proved a slow process due to inadequate labor, while the unsold stocks in London have reached dimensions such as have not been seen for a few years past. Meanwhile reserve stocks in manufacturers' hands are being used up to a large extent.

In regard to the gasoline situation, it is noted that the supply is catching up with the demand. Last month there was a cut of 1 cent a gallon in the price of gasoline from Texas. It was reported that some easiness was being felt in certain outlying New York districts, while this week it was stated that the price of gasoline in Minneapolis was quoted down 1 cent a gallon by independent dealers and half that amount by the Standard Oil. It is the consensus of opinion among oil men, however, that the gasoline market will be firm from now on and prices may go higher by the end of summer. In regard to the Texas decline of 1 cent a gallon, it is stated that the cut resulted from sharp competition among the four leading marketing interests.

Dividends Declared

Saxon Motor Car Corp., initial dividend of 1½ per cent, payable July 1, to holders of record June 20.

Electric Storage Battery Co., quarterly of 1 per cent on common and preferred, payable July 1.

Gray & Davis, quarterly of 1¾ per cent on preferred, payable July 1.

F. S. Fealy, of Motor Parts, Dies

PHILADELPHIA, PA., June 10—F. S. Fealy, president of the Motor Parts Co., was drowned on June 4 in the Delaware River. He is survived by his widow.

Security Prices React

Chevrolet, General Motors, United Motors and Overland Quotations Drop

NEW YORK CITY, June 13.—Though automobile securities made substantial gains yesterday, they did not fully recover from the general decline during the latter part of last week. Those stocks which have been features on the Exchange and the Curb were considerably lower on Saturday. General Motors dropped 73 points to 475; Chevrolet was 2 points lower; Goodrich 119 points lower and Willys-Overland 6 points under the previous week's quotations.

Violent changes in United Motors and other automobile issues featured speculation in the unlisted securities on Saturday. United Motors, for example, after selling at 80¼, broke to 71¾, only, however, to advance during the afternoon to 79¾. Perlman Rim, White Motors and Motor Products also recorded wide fluctuations pro and con. Shares of the new Durant-Willys motor combine under the name of the American Motor Co., were dealt in at prices ranging from 60 to 65. The name given this stock is only temporary and only for trading purposes. This stock was dealt on a basis of when, as and if named, a new trading basis.

In regard to the drop in United Motors Corp. issues, it is stated that this has been due to an announcement to be made in a week or so by the syndicate managers, releasing all members of the syndicate who withdrew their stock from their agreement not to dispose of it before Sept. 1.

The selling recently of United States Rubber common stock is believed to have been by interests who bought it some time ago in the hope that dividends would be resumed this summer. According to information, such action will not be taken until after the funding of the company's 6 per cent bonds and other short-term obligations is accomplished in 1918.

Chalmers common was very active with a 40-point advance as was Saxon and Chandler with 3½ and 30-point rises.

Lubricating Oil Price Advanced

CHICAGO, ILL., June 9—The Standard Oil Co. of Indiana has advanced prices of lubricating oils 2 to 5 cents a gallon in steel barrels, making Chicago wholesale basis ranging from 18 to 32 cents per gallon.

Prices in New York City and the surrounding territory remain unchanged. Polarine is selling wholesale at 30 cents a gallon in barrel lots and 28 cents in 5-barrel lots.

Prodium Is Republic's Newest

YOUNGSTOWN, OHIO, June 12.—The Republic Rubber Co. is now marketing tires constructed of a new rubber compound styled Prodium. The compound is black and is exceedingly tough. Both plain tread and non-skid are being supplied by Republic dealers and branches throughout the country.

Goodyear Plant in Toronto

TORONTO, ONT., June 8—The Goodyear Tire & Rubber Co., Ltd., is building a plant here, to be exclusively for the manufacture of pneumatic tires. The amount invested, which includes equipment costs, is between $1,250,000 and $1,500,000.

Automobile Securities Quotations on the New York and Detroit Exchanges

	1915 Bid	1915 Asked	1916 Bid	1916 Asked	Wk's Ch'ge
Ajax Rubber Co. (new)	..	..	68	70	..
Chalmers Motor Co., com	95	97	240	255	+40
Chalmers Motor Co., pfd	91	94	100	105	+1
Chandler Motor Car Co	..	..	117	120	+30
Chevrolet Motor Co.	..	..	260	262	—2
Electric Storage Battery Co	51	53	62	65	—2
Firestone Tire & Rubber Co., com	484	488	860	..	+20
Firestone Tire & Rubber Co., pfd	111	..	113	114	..
General Motors Co., com	152	154	475	594	—73
General Motors Co., pfd	100	101	113	114	—2
B. F. Goodrich Co., com	46½	48	78	78½	—119
B. F. Goodrich Co., pfd	101	103	115¼	116¼	+10
Goodyear Tire & Rubber Co., com	244	248	230	250	+33
Goodyear Tire & Rubber Co., pfd	105¼	106	105	107	—¼
International Motor Co., com	14½	15½	10	14	..
International Motor Co., pfd	37	39	20	25	—1
Kelly-Springfield Tire Co., com	129	132	74½	74½	+¼
Kelly-Springfield Tire Co., 1st pfd	83	85	96	98	..
Maxwell Motor Co., com	46	47	85½	86	—¼
Maxwell Motor Co., 1st pfd	86	87½	88½	89½	—¾
Maxwell Motor Co., 2d pfd	38	40	57½	58½	+½
Packard Motor Car Co., com	102	104	250	265	+10
Packard Motor Car Co., pfd	96¼	..†	101	104	..
Paige-Detroit Motor Car Co. (new)	..	..	50	57	—6
Peerless Motor & Truck Corp	..	..	27	27½	+2
Perlman Rim Corp.	..	..	140	145	—9
*Reo Motor Truck Co	15	15½	37	38	..
*Reo Motor Car Co	33	33½	43½	44½	—1
Saxon Motor Car Co	..	..	84½	85½	+3½
Stewart-Warner Speed. Corp., com	68	69	102	103	+16
Stewart-Warner Speed. Corp., pfd	103	105	109	110	+1
Studebaker Corp., com	75	77	142	143	+½
Studebaker Corp., pfd.	99	100½	107	110½	+1
United Motors Corp.	..	..	78¼	78½	—10¼
U. S. Rubber Co., com	65	66	56⅛	56⅛	+⅜
U. S. Rubber Co., 1st pfd	106	108	109⅝	109⅝	+⅛
White Motor Co. (new)	..	..	59¼	59½	+1⅝
Willys-Overland Co., com	131	132	304	307	—6
Willys-Overland Co., pfd	101½	103	112¼	112½	+1¼

OFFICIAL QUOTATIONS OF THE DETROIT STOCK EXCHANGE

ACTIVE STOCKS

	1915 Bid	1915 Asked	1916 Bid	1916 Asked	Wk's Ch'ge
Auto Body Co.	..	..	35½	..	+1
Chalmers Motor Co., com	91	95	..	238	..
Chalmers Motor Co., pfd	94½	97½	101	107	+5
Continental Motor Co., com	180	200	41¾	42¾	+4½
Continental Motor Co., pfd	84½	86	9½	10⅝	+¼
Ford Motor Co. of Canada	950	..	..	400	..
General Motors Co., com	150	154	470	550	..
General Motors Co., pfd	100	101	115	118	..
Maxwell Motor Co., com	45	47	85½	88	+1½
Maxwell Motor Co., 1st pfd	85	88	87	90	—1
Maxwell Motor Co., 2d pfd	38¼	40¼	56½	60	+½
Packard Motor Car Co., com	..	104	256	259	+16
Packard Motor Car Co., pfd	96¼	99	101	104	..
Paige-Detroit Motor Car Co	..	..	..	56	..
*W. K. Prudden Co	19½	21	41	45	+1
*Reo Motor Car Co	..	32¾	44	44¾	—½
*Reo Motor Truck Co	14⅜	15⅛	36¾	37¾	..
Studebaker Corp., com	75½	77½	140½	143½	+1½
Studebaker Corp., pfd	..	101	110	..	..
C. M. Hall Lamp Co	..	..	33	37	..

INACTIVE STOCKS

*Atlas Drop Forge Co	..	26	..	40	..
Kelsey Wheel Co	200	..	..	350	..
Regal Motor Car Co., pfd	..	25	17	..	..

*Par value $10; all others $100.
†Ex-dividend.

A Study of Modern High-Speed Engines

Abstract of Paper Read Before S. A. E. by A. P. Brush

(*Continued from page* 1074)

cially in high-speed engines. In the first place, the centrifugal effect of the crankpin and crank-cheek mass is increased by that portion of the lower end of the connecting-rod immediately surrounding the crankpin. In addition, the intermediate portion of the connecting-rod supplements the centrifugal effects of the crank-cheeks, the crankpin and lower end of the rod to distort the crankshaft; and further, the upper end of the connecting-rod and the reciprocating mass of the piston and piston-pin throughout certain portions of each rotation of the crankshaft also supplement these centrifugal effects toward distortion of the crankshaft. All of these tendencies combined can be lessened by the selection of proper centrifugal forces due to the added counterbalancing masses.

In order to secure the minimum tendency to distort the crankshaft, the counterbalancing mass must be greater than that necessary properly to counterbalance or neutralize the centrifugal effects of the crank-cheeks and crankpins. This is merely another way of saying that a crankshaft that alone is in the nearest triple balance possible will not have the minimum tendency to distort in service; and that a crankshaft properly counterbalanced, so as to have the minimum tendency to distort in service, will show a marked tendency to distort when run at high speed without the connecting-rods and pistons attached.

Correct Counterbalancing Masses

I shall close my discussion of crankshaft counterbalancing with a brief consideration of what are correct counterbalancing masses to permit the least tendency to displace the axis of any crankshaft under service conditions. As I have already indicated, when a method of determining these values for a single-throw crankshaft is worked out, the correct application of counterbalance to a crankshaft of any number of throws involves nothing but simple and obvious mechanical and mathematical merging of those crank-cheeks and counterbalances that, due to the omission of center-line bearings, lie in the same planes of rotation. Fig. 15 represents an end view of a single-throw crankshaft, in which A is the axis, P is the center of the crankpin, and R is the uniform radius, representing the uniform radial pull tending to displace the axis at any given rate of speed, and always acting in a plane passing through the axis A and the center of the pin P. If suitable masses whose centers of mass lie within the plane B are arranged as indicated in Fig. 4, R will be opposed by an exactly equal force acting in the opposite direction, and the value of R will become zero. Considering Fig. 16, which is identical with Fig. 15, except that the lower end of the connecting-rod immediately surrounding the crankpin has been indicated, we see that the value of R has been increased to some new value as R_1, and that the centrifugal force due to our counterbalancing masses must be increased correspondingly to eliminate all tendency to displace the axis.

In Fig. 17, representing the mechanical train, that is the piston and connecting-rod, attached to the crankpin, we find that the value of R_1 is increased and thrown into variable form, and that this variable form has two points of minimum value, as at R_2 and R_3, lying in the radial lines C and C' with radial values slightly greater than R', the lines C and C' making right angles with the center line of the connecting-rod when the center of the crankpin lies within C and C'. As the crank in its rotation approaches either of the two dead centers from the points R_2 and R_3, the resultant forces tending to displace A are increased, having (due to the finite length of the connecting-rod) a maximum value at the upper dead-center, as represented at R_4, and having still another value less than R_4, but greater than R_2 and R_3 at the lower dead-center, as indicated at R_5.

It now becomes evident that if through the addition of counterbalancing masses we are to secure the minimum tendency to displace the axis A, the centrifugal value of our counterbalancing masses must be greater than R_2 and R_3 and less than R_5. Since revolving counterbalancing masses attached to the crankshaft can have only a constant radial value for any given speed, it is at once seen that counterbalancing cannot entirely eliminate all tendencies in actual operation to displace the axis A due to the motion of the parts. There is, however, a counterbalancing value for every crank throw and for its mechanical train, which under service conditions will permit a minimum tendency to displace A.

In Fig. 18, A is the axis of the crankshaft, P is a plane of rotation about A, passing through the center line of the mechanical train and I is the intersection of A and P. At the point I the motion of parts sets up tendencies to displace A, and these tendencies can, as we have already seen, be reduced greatly by the selection of proper values of centrifugal force for counterbalancing masses indicated at M and M', whose resultant centrifugal effect due to their symmetrical arrangement on each side of the plane P lies within the plane P.

No matter how many throws or what the form of a crankshaft, there will be a point I for every throw, and the resultant tendency to displace A at each of these points will be identical, irrespective of the number of throws or their angular relation. It is entirely immaterial, so far as these effects are concerned, whether center-line bearings are interposed between the throws.

Author's Conclusion

If this were not already too long, it would be interesting to analyze further the forces occurring at I. However, the analysis as it stands is sufficiently complete for the practical purpose of computing the proper centrifugal values for counterbalancing masses for all conventional types of engines, in which only one piston and connecting-rod are attached to a single crankpin.

With V engines it is also true that the entire problem of correct counterbalancing is involved in the determining of correct counterbalancing values for a single crank throw.

I have not attempted to exhaust the subjects under discussion, and have omitted entirely several interesting phases of high-speed engine design, as, for example, the analysis of the valving train, various installations of electrical and other auxiliary equipment, carbureter location, and intake manifold sizes and forms as affected by increased engine speeds.

No Discussion on the Paper

There was no discussion of the paper by Mr. Brush, and the discussion of the other papers was rather brief, owing to lack of time. The paper by D. D. Ormsby on Differential Substitutes and that by Herbert Chase and A. Browne on Possibilities of the Constant Pressure Cycle, are reprinted in part on the following pages.

Substitutes for the Differential

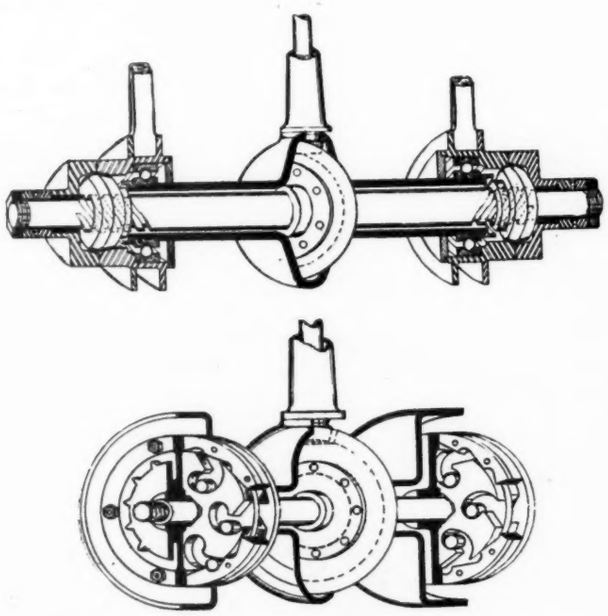
Divided Into Four Classes: Free-Wheel, Crank and Eccentric, Spiral Differential and Solid Axle Types—Advantages and Disadvantages of the Various Constructions

By D. D. Ormsby
Chief Engineer, Brown-Lipe-Chapin Co.

THE conventional differential rather than being inefficient is on the other hand too efficient in that it differentiates for all differences, whereas the automobile engineer wants it to take care only of the unequal velocities of the rear wheels. It becomes inefficient as a means of transmitting the power to the rear wheels if the wheels have unequal traction. It is to correct this defect of differentiating for unequal traction of the wheels that a great many intended substitutes for the present types of differential have been invented. I will describe a few of them briefly.

The substitutes can be divided into four classes: The free-wheel type, Figs. 1, 2 and 3; crank and eccentric, Fig. 4; spiral differential, Fig. 5; and the solid axle.

Fig. 1 shows the Hedgeland solid anti-skid automobile axle, of which little has been heard for some time. As the name indicates, this axle was constructed with a continuous or solid axle, having a thread cut on both ends. To these threaded ends were attached cone clutches having a double taper, so that when the power was applied to the axle these clutches were forced one way or the other by means of the thread on the shaft and they gripped a cup which was attached to the wheel, thus transmitting the power from the shaft to the wheels. When a car equipped with this device was making a turn or diverging from a straight course, so that the outer wheel was obliged to travel faster than the inner wheel, the outer wheel was automatically declutched and ran free on the axle around the clutch on the shaft. Fig. 1 is a sectional line drawing of this construction, and shows the mechanism clearly.



Above—Fig. 1—Hedgeland anti-skid axle. Below—Fig. 2—Free-wheel type of axle

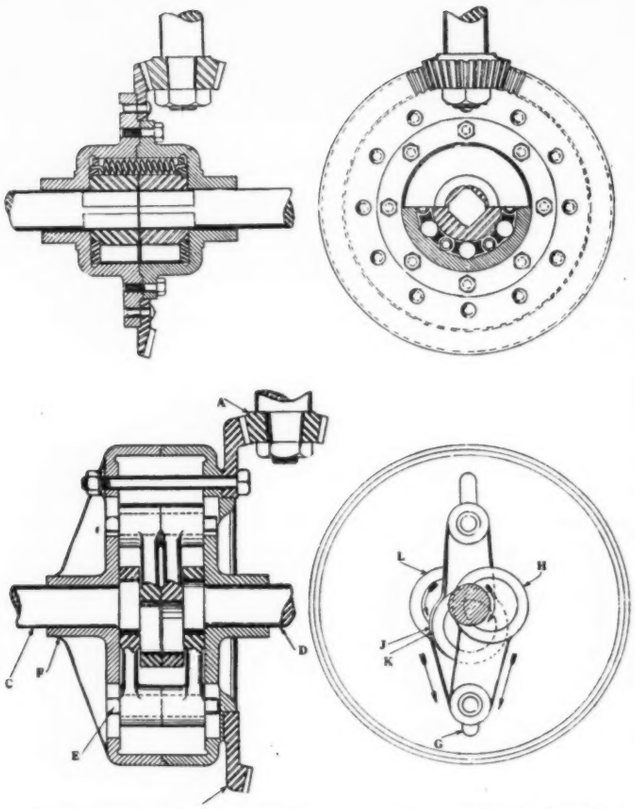
Fig. 2 represents a design similar to the one in Fig. 1, and the same principle is utilized, namely, having a loose wheel when the car is diverged from a straight line, so as to differentiate for the unequal velocity of the two rear wheels. Fig. 2 is a perspective view of a jackshaft equipped with this design. It is practically the same as the Hedgeland design, with the exception of the clutching mechanism, in that it employs a solid axle, to the center of which is fastened the bevel drive gear and on the ends of which the clutches are applied. In this case the clutches consist of two cams on each side, keyed or secured by some other means to the shaft; when driving forward or backward they force rollers out against a drum to which is attached the sprocket or rear wheel. By wedging these rollers against the drum the power is transmitted from the cam to the drum and thence to the rear wheels. Both wheels are gripped alike when the car is being propelled in a straight line but when the car diverges from a straight line, as in turning a corner, the outer wheel runs faster than the inner wheel, forcing the rollers back so that it is released from the cam and hence from the shaft, and allowed to rotate faster than the inner wheel.

Another Substitute

The substitute shown in Fig. 3 is of similar design to the one shown in Fig. 2, in that cams and rollers are employed, but it is mounted in the conventional position instead of in the hubs of the wheels, and its action is the same, that is, when the car is being driven in a straight line both cams are clutched to the drum which drives both wheels at the same speed. When the car ceases to run in a straight line the outer wheel accelerates ahead of the inner wheel, declutching the cam attached to the shaft of the outer wheel.

Free-Wheel Differentiation

The action of the free-wheel type differential is such that it eliminates the inherent defect in the standard differential; that is, differentiating when the wheels have unequal traction. Yet there are some points in its action which are not entirely satisfactory. In the first place, with unequal size tires it drives more on the large tire, because the wheel with smaller tire has to rotate faster to make up for the distance traveled by the wheel having the larger tire. Secondly, in making a turn all the power is applied to the inner wheel and hence must be transmitted through one shaft. This throws an extra heavy load on the inner wheel, especially when making a turn on a steep hill. One other feature has, according to the experience of a car manufacturer, proved to be a serious defect. This is the shock of applying the brake when the car is not running in a straight line, for when making a turn the outer wheel, being free from the axle, is more sensitive to the brake than the wheel which is transmitting power. The outer wheel will be retarded



Above—Fig. 3—Cam and roller type of free-wheel mechanism.
Below—Fig. 4—Crank and eccentric type of differential

much more rapidly than the inner wheel. There is considerable shock when it slows down to a point slower than the inner wheel, and the differentiating mechanism is obliged to pick it up.

The Crank and Eccentric Type

The second type of differential substitute is shown in Fig. 4. For convenience I will call it the crank and eccentric type. I was unable to obtain the name of the inventor of this differential and believe it has not been tried out to any great extent. It is an interesting device composed of two axle shafts designated as *C* and *D* in the reproduction. At the ends of these shafts are turned two eccentrics, to which are attached four cranks, designated *H*, *K*, *J* and *L*; *H*, *K* being attached to the eccentrics on shaft *D* and *J*, *L* to the eccentrics on shaft *C*. These cranks carry bosses which are bored and through which are passed sliding pins *E* and *I*, upon which the cranks are centered and oscillate. The cranks *L* and *H* are attached to sliding pin *E* and *J* and *K* to sliding pin *I*. These pins are allowed to slide in slots in the case *F*, which is made in two halves bolted together. The action is as follows: The power applied to the bevel driving pinion *A* is transmitted to drive gear *B*, which is attached to and therefore rotates the case with the gear. When the car is traveling in a straight line, the sliding pins *E* and *I* rotate with the case, and the whole differential mechanism is rotated. When the car diverges from a straight line and the wheels have unequal velocities, the outer wheel speeding up oscillates the cranks by means of the eccentrics on the shaft, the cranks being allowed to oscillate around the center of the axis of the shafts and the eccentrics placed at such an angle in relation to each other that the required reverse direction of motion of the shafts is obtained. This allows the outer wheel to speed up and the inner wheel to become retarded, but because the angles of the eccentrics are so sharp, when one wheel loses traction it does not spin. I have never seen one of these differentials tried out and do not know how efficient it is, but it is ingenious and unique.

The Spiral Gear

The third type, which has received considerable attention, is the spiral gear. This differential is similar to the conventional type, except that its differentiating gears are made up of a train of spiral instead of bevel or spur gears. Its action is the same in principle as that of the bevel or spur gear types, but the spiral gears are placed in such a manner as render the differential train inefficient, so that it is impossible to spin one wheel without rotating the other. Fig. 5 is a perspective sectional view of the type. It seems that a design of this nature should be the ultimate solution of the present differential problem, for it is evident that both wheels should be connected to each other at all times by some means and that the power should be applied to both wheels under all conditions, which is accomplished in this design. This type is being used with marked success by one company in four-wheel drive trucks.

Differential Eliminated

The fourth "substitute" consists of the elimination of the differential altogether. The advantages of this construction are that it obviates the spinning of the wheels, insures a positive drive of the wheels under all conditions and makes possible a reduction in cost. The disadvantages are, however, in my opinion, too great to be overcome. Writers in the trade papers seem to advance the theory that the slippage is greater in making a short turn than in making a turn of larger radius through a given angle. In the solid type axle with the differential eliminated there must always occur, when the car is making a turn, slippage of the inner or outer wheel, or both wheels. It is hard to demonstrate exactly what happens. I have figured just how much slippage there is in making a turn of 90 deg. with a certain light touring car and a well-known runabout. I found by measuring the amount the front wheels can be turned in steering, that the touring car can be turned in a radius of 17.13 ft. (205.6 in.). This is the radius at which the inner wheel turns. The standard gage being 56 in. the outer wheels would turn in a radius of 261.6 in. The distance traveled by the outer wheel in a 90 deg. turn is 410.9 in. The inner wheel would travel 322.9 in.; a difference of 88 in. to be compensated for by the slippage of the wheels. The total circumference of the touring car 32-in. tire is 100.53 in. The amount of slippage di-

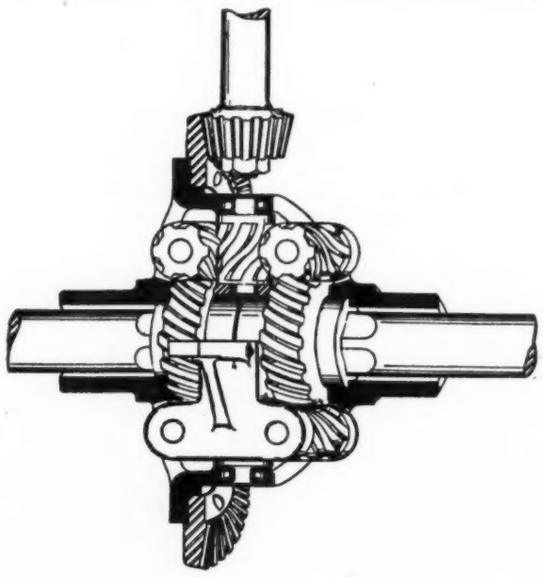


Fig. 5—Differential with spiral gears

vided by the circumference of the tire gives the proportion of revolution which the wheel has to slip in making a turn of 90 deg., and is 0.87.

The shortest radius at which the runabout examined can be turned is 13.9 ft. or 166.7 in. This is the radius at which the inner wheel turns. The outer wheel radius is 222.7 in. The distance the outer wheel travels in making a turn of 90 deg. with this radius is 350 in. The inner wheel travels 262 in. in making the same turn, the difference being 88 in., the same as with the touring car. I proved to my own satisfaction that the difference in travel between the inner and outer wheels in making a turn at a given angle depends upon the gage and not upon the radius of the turn. Taking the runabout tire diameter as 30 in., the circumference is 94.248 in. and the amount the wheel would have to slip 88 in. This divided by the circumference of the tire gives the part of the revolution that the wheel has to slip in making a turn of 90 deg., which is 0.93. No matter how great the radius, the amount of slippage through a given angle is always the same, for the difference in travel depends upon the gage and not upon the radius. Therefore with a solid axle no matter how slight the divergence from a straight line, an extra load, caused by the difference in travel of the two wheels, is always thrown upon the rear axle, wheels and tires. With a larger radius the slippage is not so noticeable, of course, as it occurs through a greater space.

S. A. E. On Record Summer Cruise

(*Continued from page* 1065)

material which had entered into a marvelous number of industries. When mixed with wood pulp and molded it is used for a great variety of purposes and can be molded to take any desired form. He told of how Mr. Hyatt started in search of a billiard ball which would be more resilient than ivory and as a possible result founded the Hyatt bearing company, the celluloid industry and finally kept on even after these two great by-products had been achieved until in conjunction with Dr. Bakel and Charles Burroughs he made the Bakelite ball which has a much greater elasticity than that of ivory. This was demonstrated on the scieroscope before the audience by Mr. Kettering.

A Study of Heat

The speaker then led his hearers into the mysteries of heat. The effects of heat are shown in the movements of the molecules of which a body is composed and hence the effect of a warm body upon a colder or *vice versa* is due to the collision of molecules moving at different relative velocities. Hot objects have rapidly moving molecules, cold ones have slower moving molecules. The effect of cooling a body is to slow up the molecules. Mr. Kettering demonstrated the condition of molecular cohesion in cold bodies by immersing several objects in liquid air. A rubber ball, a flower and a metal container were all shown to have their structural strength destroyed by the slowing of the molecules. A piece of mercury was frozen and cast in the shape of a hammer and Mr. Kettering drove several nails into a wood block with it, thus showing a strength increase caused by low temperature. Liquid air has a temperature of about 375 below zero.

Mr. Kettering then came to the subject of the earth's supply of energy. He gave as an illustration the bean, which is supplied with just enough energy to bring it through the crust of the earth, and he stated that the supply of petroleum was probably just enough to do the the same for the human race before it passed to other sources of power. The sun is the only source of energy, and until we can couple with it directly, we will not be perfect. As as illustration of the sun's power of pumping, he mentioned how the great lakes and the big rivers were kept perpetually full, entirely by solar energy.

62,000,000 Hp. in Automobile Engines

The enormous sources of water power which we have at our disposal were touched upon. He compared the 600,000,000 hp. available at present from water power to the 62,000,000 hp. generated by existing automobile engines, and stated that the ratio of supply to demand is greatly in our favor. We have available 25,000,000 hp. of animal energy. It takes 125,000,000 acres of land to feed these animals. Mr. Kettering said it would be a poor chemist that could not produce more horsepower than that from this huge area of ground. The speaker dwelt on the impractical suggestion of adding a few drops of material to water in order to produce energy by separating the hydrogen from the oxygen, as the amount of energy necessary in doing this is equivalent to that secured by combustion. It it were possible to change the air and have a greater percentage of oxygen we would be able to use fuels that are not now possible.

Radium and Its Possibilities

Mr. Kettering then spoke of radium as being one of the things about which we still know little and which might become very important. When this substance was first discovered scientists were puzzled by the fact that the air in a box containing radium was always warmer than the outside air. Eventually they found that the radium lost weight very slowly. Radium throws off particles of itself at an incredible velocity and it is the kinetic energy of these particles which causes the warming up of the surrounding container. The strength of a piece of steel is many thousands of pounds per square inch. If we could find means to let loose the energy which binds together the molecules of the steel we should have an inexhaustible source of power. As an example of this, the molecular forces holding together a grain of corn would provide over 2000 hp. for 24 hr. if we could find means for letting them loose.

The accuracy of measuring machines was touched upon and it was shown that with the interferometer it is possible to check within 1/1,000,000 part of an inch.

Mr. Kettering closed with a demonstration of the powers of the high frequency electrical current. He showed how a lamp could be lit through blocks of glass over 1 in. thick in spite of the fact that glass was supposed to be an excellent non-conductor. The frequency of the machine he used was 2,000,000 per second. In the meantime he had passed around samples of the various materials of which he had spoken, including several thousand dollars worth of radium.

Papers and Discussions

SS. NORONIC, Great Lakes, June 13 (*Special Telegram*)—To-day's proceedings opened with the reading of the paper on differential substitutes by D. D. Ormsby, Brown-Lipe-Chapin Co. The discussion was condensed somewhat to enable the morning's program to be covered. Secretary Clarkson first read a written communication from R. E. Wells, American Gear & Mfg. Co., supplementing Mr. Ormsby's arguments, and said that there seemed one difficulty in regard to the design of an ideal differential. What is wanted is a mechanism which will differentiate freely for corner turning and will not differentiate when traction differs in the two rear wheels through changes in the condition of the road surface. In other words, the differential substitute is required

to distinguish between difference in traction due to road surface condition and difference in traction due to making a turn. The mechanism cannot be expected to do this.

Favors Free-Wheel Type

W. H. Diefendorf, New Process Gear Corporation, spoke in favor of the free-wheel type of mechanism, saying that 15,000 of these had gone into use during the past year. He said that the friction which is the feature of the spiral type differential must be objectionable, and as proof of its considerable magnitude he mentioned that a car with a differential of this sort exhibited a strong tendency to straighten out again after making a turn. With the free-wheel type, he said, no such action is observable.

Herbert Chase then read a letter from G. W. Smith, Thomas B. Jeffery Co. Mr. Smith gave it as his opinion that the ordinary rubber tire made a good differential as long as the radius of a turn was large enough to make the slip only from 2 to 4 per cent of the total distance traveled. The ideal would be a differential that would allow about 30 per cent but no more, which would cease to act as a differential when the difference exceeded this amount. This would prevent wheel-spinning and yet give perfect action on the sharpest turns.

A Year Without a Differential

A. Ludlow Clayden recited some experiences of his with a car of 90-in. wheelbase and 4-ft. tread, which he drove for a whole year without any differential. He said that on the whole the advantages and disadvantages were about evenly balanced. He didn't notice any increased tire wear, but there was grave risk of serious damage to a tire that became deflated if an instant stop was not made. He asked Mr. Ormsby what was the backlash in the spiral type differential and whether the internal friction provoked wear which increased this lost motion. The Hedgeland axle made experimentally years ago had a pronounced amount of backlash, and this caused a bump when the throttle was closed and the car commenced to drive the engine.

Ormsby made a short reply, at the request of President Huff, and said that the backlash in the spiral gear was about the same as in the normal type. He had driven a heavy car 12,000 miles with a spiral differential and could not observe any more lost motion at the end than at the beginning. He explained this by saying that the pinions in the spiral gear practically locked solid when any spinning tried to start.

Advocates Truck Formula

John Younger, chief engineer of the truck department, Pierce-Arrow company, submitted a written discussion on Professor Gallup's paper. This was read by K. W. Zimmerschied after he had read Professor Gallup's paper. Professor Gallup pointed out in his paper the fallacy of giving tests made under special condition as representative of stock car performance. He also dwelt on the advantage which would accrue from having a standard rating formula which would enable buyers to compare performance and price in making a choice.

Mr. Younger's communication dwelt on the desirability of a formula which would take into consideration something besides the mechanical measurements of the car. He particularly favored the sigma formula. This formula has been mentioned previously in THE AUTOMOBILE. It reads

$$\Sigma = \frac{0.0039\, d^2 \times S \times N \times G \times M}{D}$$

Where d equals bore, S equals stroke, N equals number of cylinders, G is gear ratio, M is gasoline consumption in miles per gallon, and D is the diameter of the wheels.

Mr. Younger gave some of the values of Σ, the highest being 4.7 under the most advantageous conditions.

British Railroads Use Motor Buses and Trucks

LONDON, June 8 — Nearly 500 motor vehicles were owned and operated last year by the principal steam railroads of the United Kingdom. The number was somewhat less than in 1914, owing to the requirements of the War Office, which requisitioned some of the vehicles for army purposes, taking, for example thirty-two of the London and North Western's fleet of fifty-two omnibuses. It is expected, however, that this year will show a considerable increase.

The British railroads collectively possessed 223 motor buses last year and more than 250 trucks and vans for hauling parcels, baggage and freight. The largest fleet were as follows:

Railroad	Buses	Trucks
Great Western	109	95
London and North Western	20	75
North Eastern	43	17
Midland	2	38
Great Northern of Scotland	36	..
London and South Western	2	27

The Midland doubled its fleet of trucks last year and the North Western increased its fleet 50 per cent.

These road vehicles are used principally as connecting links between the main lines and towns located some distance back from the railroads.

There is a big opportunity for similar use of motor vehicles by the railroads and interurban electric lines in the United States for serving communities too small to make the construction and operation of branch roads profitable.

—

United States Buys More F. W. D. Trucks

CLINTONVILLE, WIS., June 12—Another order for twenty-eight 3-ton transport trucks and five additional 600-gal. tank trucks has been placed with the Four Wheel Drive Auto Co., this city. An order was also given the Peerless company at the same time.

—

To Make Wheel for Fords

GRAND RAPIDS, MICH., June 8. — The Simplicity Demountable Wheel Co. has been organized by Frederick W. French and I. Bates and is operating at 412 Bond Avenue, N. W. The company manufactures regulation wheels for Ford automobiles.

—

Phelps Co. to Make Wire Wheels

COLUMBUS, OHIO, June 8.—The Phelps Manufacturing Co., incorporated several months ago with a capital of $100,000, has been organized by the election of H. C. Phelps, president; Dr. C. K. Wissinger, vice-president; T. W. Pickard, secretary, and L. M. Reif, treasurer. The concern took over the business of the F. & H. Wire Wheel Co., formerly of Columbus, but later of Springfield. The plant has been moved to Columbus and it is planned to manufacture 80 sets of wire wheels daily.

—

Pantasote Tops on Chalmers

DETROIT, MICH., June 10.—The Pantasote Co. has closed a large order for top material with the Chalmers Motor Co., and its product, Pantasote, will be standard top material on the new Chalmers model seven-22.

—

To Make Two-Speed Gears

COLUMBUS, OHIO, June 8.—The C. A. S. Products Co., incorporated recently with a capital of $100,000, is a reorganization of the Foster Gear Co., which holds patents on a two-speed gear. The company is preparing to manufacture the gears in large numbers. The rights to make the gears have been sold to several large automobile concerns, notably the Cadillac company. Incorporators are C. S. M. Krumm, C. D. Cutting, J. W. Graham, A. W. Tyler and Dorothy Loechler.

Constant Pressure Cycle Possibilities

Comparison of the Various Engine Cycles, Touching on the Advantages and Disadvantages of Each Type with Special Reference to the Constant Pressure Cycle

By Arthur B. Browne
Consulting Engineer
and Herbert Chase
Chief Engineer, Automobile Club of America

THE liberation of heat energy in a gas engine depends for its efficiency upon several conditions that may exist prior to ignition and during the combustion period. The efficiency is a maximum when the following conditions obtain:

(a) The density or compression of the charge is the greatest possible.

(b) The temperature prior to ignition is the highest possible.

(c) Oxygen is present in quantities just sufficient for complete combustion.

(d) The admixture of fuel with the necessary oxygen is perfect, that is, when the charge is absolutely homogeneous.

(e) Inert and diluting gases are absent.

Combustion may be divided into three main classes.

In *Class A* all the oxygen is furnished by the supporting atmosphere without admixture prior to combustion. An illustration of this is the luminous gas flame, in which gas issuing from an orifice finally comes in contact with the oxygen of the air and burns with a luminous flame of low thermal efficiency. It will be noted that Class A fulfills none of the conditions previously enumerated as making for efficiency because: (a) Both gas and air are at atmospheric pressure; (b) The temperature prior to ignition is low; (c) Much more oxygen is present adjacent to the combustion zone than is necessary and this excess is heated without useful purpose; and (d) There is no intimacy of the mixture, the gas molecules being forced to "seek" their proportions of oxygen before combustion can occur. Hence in the luminous gas burner the gas is caused to issue in a thin sheet, whereby its surface is made as great as possible in proportion to its volume.

In *Class B* part of the oxygen is mixed with the fuel, the remainder being furnished by the supporting atmosphere. This class is illustrated by the Bunsen burner and its thermal efficiency is, obviously, far greater than that of Class A. In this case the first three conditions are not complied with, the increased efficiency being clearly due to a partial compliance with condition (d.)

In *Class C* fuel and air are mixed in such proportions that there is just sufficient and no excess of oxygen, so that combustion ensues without regard to the gaseous medium in which it takes place. This is sometimes called "flameless" combustion, from the fact that the combustion is so rapid and so thorough that it takes place by concussive propagation between the molecules, in a very limited zone, almost a sheet, which is termed the "flame cap."

Class C, however, embraces combustion within the mass—a true molecular interchange confined to the sheet of flame cap only because at that point alone the rate of propagation between the molecules exactly balances the rate of flow.

In the case of flameless combustion there is no dilution of the unburned gases by the burned. The mixture of gas and air approaches the flame cap, complete and instantaneous combustion takes place and the products of combustion move away.

Comparison of Engine Cycles

Internal combustion engines may be classified as follows:

Class I.—Engines operating on constant volume cycle.

Class II.—Engines operating on constant temperature cycle.

Class III.—Engines operating on constant pressure cycle.

The Otto Cycle

To the first class belongs the Otto cycle, applied universally at the present time for internal-combustion automobile engines. Its chief advantages are its flexibility and adaptability to relatively lightweight and therefore to easily portable units. Its disadvantages are many and include the following:

(1) Poor thermal efficiency under the average condition of low compression pressure, which results from throttling of the charge and which (at maximum) must be relatively low to prevent self-ignition when a fuel rich in hydrogen (such as gasoline) is used.

(2) High explosion pressures occurring so suddenly as to deliver what practically amounts to a hammer blow on the piston head. To meet this condition the parts must be much stronger (and heavier) than they would otherwise need be to accommodate the relatively low mean effective pressure produced.

(3) Large clearance space required to admit of the low compression pressures necessary with rich and volatile petroleum fuels, which are practically the only fuels commercially available that will give reliable operation under varying load conditions. This clearance space is always filled with burnt gases, which dilute the incoming charge of unburnt gas.

(4) Impracticability (especially in light high-speed units) in cases where only heavy or relatively non-volatile fuels are available. This applies only to oil; that is, not to gas engines.

Combustion in the Otto cycle is superior by reason of its partial compliance with conditions (a, b, c and d) above. Combustion in this cycle clearly falls under Class C and would be highly efficient were it not for unavoidable losses and inherent limitations. But under condition (a) we find the density of the charge is limited by liability to pre-ignition, and under (b) the same limitation is placed on the pre-ignition temperature; as to (c) and (d) it is to be noted that the proportions and intimate admixture of the fuel and air depend on the efficiency of the carbureting device used. This is never perfect and is usually far from ideal. From condition (e) it is evident that the presence of burned gases in the charge not only serves to lessen the unit weight of charge

taken in but entails a direct loss because of the heat delivered to these products of combustion.

The Constant Temperature Cycle

No engines practicable for motor vehicles have ever been developed using this cycle (Class II).

The Diesel Cycle

The Diesel cycle has several inherent advantages. High thermal efficiency, adaptability to use of heavy oils, variable cut-off (within certain limits) and high compression temperatures making ignition devices unnecessary, are foremost among these. Its disadvantages, on the other hand, are quite as numerous and in some cases insurmountable where small light-weight units are required. These disadvantages have to do largely with the high pressures encountered and include the following: (1) High compression and explosion pressures making necessary heavy and close-fitting parts, difficult to keep tight (engine may become inoperative if not tight); (2) Necessity for high pressure fuel injection pump, and separate air compressor; (3) Mechanical difficulties in regulating the minute quantities of fuel discharged by the pump to accommodate different loads; (4) Fuel admission line limited by the relatively small volume (entailed by the high compression necessary) to be heated by combustion; (5) Difficulties in starting with resultant complication; and (6) Low mechanical efficiency owing to close fitting parts (especially piston rings.)

The Semi-Diesel Cycle

The hot-bulb or so-called semi-Diesel engines possess most of the advantages of the Diesel type, although they are less efficient because of the lower compression pressure employed. They are limited as to power output per unit of weight on account of disadvantages similar to those of the Diesel cycle. This alone would preclude their adoption for motor vehicles.

The Constant Pressure Cycle

Let us now consider engines belonging to Class III. The advantages of this type are numerous and the disadvantages encountered in the past have had to do almost entirely with constructional difficulties. While the former have long been appreciated, not to say regarded as ideal, the latter have stood in the way of progress and have operated against the development of any commercially practicable* engine applying the principle of this cycle—this excluding, of course, engines operating on the Diesel or semi-Diesel cycles as not, strictly speaking, belonging to the constant pressure cycle class (see previous reference to Diesel cycle engines, under heading "Constant Temperature Cycle").

In order to have in mind exactly what is meant by the constant pressure cycle let us first consider the succession of events. A theoretical card for this cycle is shown in Fig. 1, in which AB represents adiabatic compression from atmospheric to maximum pressure; BC, addition of heat isopiestically; CD, adiabatic expansion from maximum pressure to atmospheric pressure; DA, cooling at atmospheric pressure. Note that heating is effected at constant pressure, and that this pressure is the maximum pressure of the cycle. There is no sudden rise in pressure at ignition as in the Otto cycle.

Advantages of the Constant Pressure Cycle

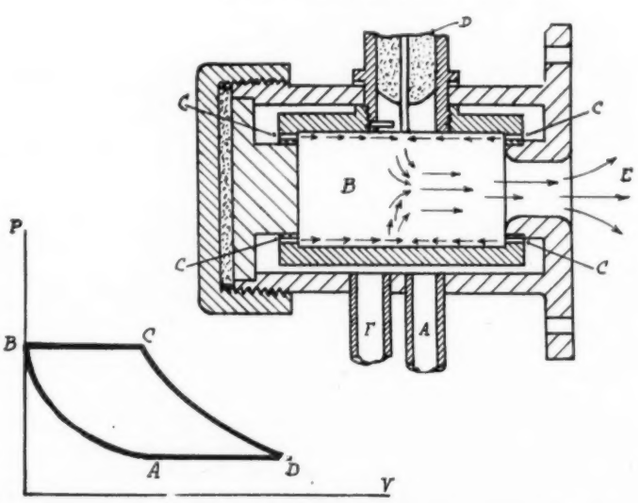
1—Inspection of the card given in Fig. 1 at once makes evident the two cardinal advantages of the cycle; (a) the large area indicating high mean effective pressure and (b) the low maximum pressure. In practice these are factors of utmost importance. They result in high and relatively uniform torque, large power output per unit of displacement and relatively low maximum bearing pressures and unit stresses on parts, with consequent light weight and length of life.

2—The possibility of varying the point of cut-off is practically the same as that in the ordinary steam engine. The variation can be made through such a wide range that the engine accommodates itself to most if not all variation in load. This fact is of utmost importance, since it operates to make the cycle practically as efficient at part load as it is at full load. No corresponding variation to meet changes in load is possible in the Otto cycle unless with "hit or miss" governing, which of course is not feasible for motor car engines. Variations in load are taken care of as a rule by throttling of the charge with consequent decrease in compression pressure. The thermal efficiency in any cycle falls rapidly with a decrease in compression pressure. In the automobile engine, for example, a maximum thermal efficiency of about 20 per cent is obtainable under full load conditions; the thermal efficiency can fall as low as 2 or 3 per cent under light load when the charge is throttled and the compression pressure correspondingly reduced. Since automobile engines run throttled during a large part of the time their thermal efficiency is necessarily low. Inspection of the card of the constant pressure cycle, Fig. 1, shows the feasibility of making the admission line BC so short (by means of an early cut-off) as to cause the expansion line CD to fall practically on the compression line AB. By this means it is probable that the lightest loads can be carried at the maximum pressure of the cycle with practically the same fuel efficiency as at full load. This being the case, throttling of the charge would take place only in starting.

Use of Low Grade Liquid Fuel

3—The importance of this factor in view of the constantly advancing price of highly refined petroleum distillates is readily apparent. The method by which low grade fuel can be utilized will be outlined later. But engines of this type can be made to run on quite as heavy an oil as can be utilized in any Diesel engine and with far better combustion conditions than are possible in the Diesel type. Self-contained constant pressure engines can therefore be expected to replace those of the constant volume type in the small size light weight class as rapidly as the Diesel engine has replaced the Otto cycle engine in the heavy weight class, where fuel cost is much in favor of the former. It is not at all unlikely that even the highly efficient Diesel engine will give place to the constant pressure type of engine when its advantages over the Diesel type are fully realized.

(*To be continued*)



Below—Fig. 1—Theoretical card for constant pressure cycle.
Above—Fig. 3—Representation of burner

*Messrs. Carpenter and Diederichs state in their book on the Internal Combustion Engine that the Brayton oil engine was a thoroughly practical engine and saw wide application. This was true in its day but the engine has long since been abandoned, partly because of its inefficiency as compared to the modern Diesel types, but more especially because of cumbersome design and failure of its inventor to grasp certain important details of construction that will be treated of later.

Factory Miscellany

Body Plant in Dodgeville—Schroeder Bros., Milwaukee, Wis., are contemplating the establishment of an automobile body plant in Dodgeville, Wis.

Findeisen & Kropf to Add—The Findeisen & Kropf Mfg. Co., Chicago, Ill., will build a 25 by 110-ft. foundry at 2519 West Twenty-first Street, that city.

Warner to Add—The T. W. Warner Co., Muncie, Ind., maker of automobile parts, has had plans prepared for the erection of an addition to its plant, 85 by 125 ft., for which it contemplates the purchase of new machinery.

Fulton Tractor Plant in Anderson—The Fulton Tractor Mfg. Co. has taken over a plant in Anderson, Ind., which it will adapt for the manufacture of farm tractors and possibly automobiles. The company was recently organized with a capital of $300,000.

To Make Lamps in Knoxville—The Safety Automobile Light Co., Knoxville, Tenn., has been organized with $25,000 capital and contemplates building a plant to manufacture a special lamp for automobiles. J. G. Buchanan, A. M. Treadwell and others are the incorporators.

To Manufacture Fan—With orders from a number of large automobile companies, including one of 50,000 instruments from the Smith Form-A-Truck Co., the Pitter Fan Co. has started the manufacture of the Pitter automobile fan at 111 North State Street, Elgin, Ill. The company is specializing at present on a fan for Ford cars and trucks.

To Make Folding Berths—The Bradley Mfg. Co., Tacoma, Wash., R. L. Bradley, president, will establish a plant in Steilacoom, Wash., for the manufacture of a patented folding berth for automobiles. The enterprise is being backed by the Tacoma Commercial Club and Chamber of Commerce.

Davis to Add—The Davis Mfg. Co., Milwaukee, Wis., has increased its capital stock from $300,000 to $500,000 to accommodate its increasing business. The company recently took occupancy of its new plant at Fifty-sixth Avenue and Mitchell Street, West Allis, erected at a cost of more than $250,000.

Ford Plant in Duluth—The Ford Motor Co. will construct a plant at Duluth, Minn., at an estimated cost between $500,000 and $1,000,000.

This company recently took title to a parcel of land in Cleveland, Ohio, costing about $55,000. The property is 265 by 135 ft. in size. About half of it will be used for a two-story sales and service station.

It is also stated that the company is planning a factory for Des Moines, Iowa, on Grand Avenue.

Maxwell Starts New Castle Additions—Construction of the addition to the Maxwell plant in New Castle, Ind., has been begun. The new addition will take the shape of two large buildings, one to be used as a forge and hammer shop and the other to be used as a die shop. The forge and hammer shop will be in a large building, 550 by 80 ft., and will be constructed of concrete, brick and glass.

The building which is to contain the die shop will be erected between the new forge and hammer room and the main building of the plant. This building will be 220 by 90 ft. and of the same material as the other building.

Because of the call for additional power that the new addition will make, an addition to the present power plant is also under construction. The addition will be two stories in height and will be 54 by 45 ft.

Ill. Factory Items—F. G. Bain of Quincy, Ill., has purchased 4 acres of land near Bushnell, upon which he will construct a factory for the manufacture of automobile accessories. Bain has secured a number of patents upon various devices and will manufacture them upon a large scale. He will employ forty men at the outset. Originally Mr. Bain planned to purchase the plant of the Bushnell Tank Works and manufacture the latter's product in conjunction with his own inventions. He decided, however, to permit an option to lapse, preferring to keep the two lines separate.

The Barley Mfg. Co., Streator, has been given the central Illinois distribution for the Halladay car.

The Automobile Calendar

ASSOCIATIONS

June 12-16—S. A. E. Summer Trip on Great Lakes.
July 2-6—Detroit, Mich., World's Salesmanship Congress, Detroit Board of Commerce Bldg.
Dec. 2-9—Electricians' Country-wide Celebration.

CONTESTS

June 17—Newark, N. J., Track Race, Olympia Park, Auto Racing Assn.
June 20—Galesburg, Ill., Track Race, 100 miles.
June 22-23—Chicago, Interclub Reliability Run, Chicago Automobile Club.
June 26 — Des Moines, Iowa, Speedway Race, Price Speedway Co.
June 28 — Des Moines, Iowa, Speedway Free - for - All, 300-Mile Race.
July—La Grande, Ore., Track Race, LaGrande Motor Club.
July 4—Coeur d'Alene, Idaho, Race Meet, Hiller-Riegel Co.
July 4—Tacoma, Wash., Speedway Race, Tacoma Speedway Assn.
July 4—Minneapolis 300 - Mile Speedway Race.
July 4—Sioux City Speedway Race.
July 4—Newark, N. J., Track Race, Olympic Park, Auto Racing Assn.
July 4—Visalia, Cal., Road Race, Tulare Co. Auto Club.
July 4—Spokane, Coeur d'Alene, Track Race, Reigel-Hiller Co.
July 4—Benton Harbor, Mich., Track Race, F. E. Fitzsimmons.
July 4—Elmira, N. Y., Track Race, Elmira Auto and Motorcycle Racing Assn.
July — Burlington, Iowa, 100-Mile Track Race, Tri-State Fair.
July 15—Portland, Ore., Track Race, Northwest Auto Assn.
July 15—Omaha, Neb., Speedway Race.
July 15—North Yakima, Wash., Track Race, Hiller-Riegel Co.
Aug. 5—Tacoma Speedway Race, Tacoma Speedway Association.
Aug. 11-12—Pikes Peak, Col., Hill Climb, Pikes Peak Auto Highway Co.
Aug. 12—Portland, Ore., Track Race, Hiller-Riegel Co.
Aug. 18-19—Elgin Road Race, Chicago Auto Club.
Aug. 26—Kalamazoo, Mich., 100-Mile Track Race.
Sept. 1-2—New York, N. Y., Sheepshead Bay Speedway, 24-Hour Race, Trade Racing Assn.
Sept. 4—Elmira, N. Y., Track Race, Elmira Auto and Motorcycle Racing Assn.
Sept. 4—Cincinnati, Ohio, Speedway, Cincinnati Speedway Co.
Sept. 4—Newark, N. J., Track Race, Olympic Park, Racing Assn.
Sept. 4—Indianapolis Speedway Race.
Sept. 4—Des Moines Speedway Invitation Race. Limited to six entries.
Sept. 4-5 — Spokane, Wash., Track Race, Inland Auto Assn.
Sept. 16—Providence Speedway Race.
Sept. 18—North Yakima, Wash., Track Race, Washington State Fair.
Sept. 29—Trenton, N. J., Inter-State Fair. H. P. Murphy, Racing Sec.
Sept 30 — New York City, Sheepshead Bay Speedway Race.
Oct. 7 — Philadelphia Speedway Race.
Oct. 7—Omaha Speedway Race.
Oct. 14 — Chicago Speedway Race.
Oct. 19—Indianapolis, Ind., Race, Indianapolis Motor Speedway.
Oct. 21 — Kalamazoo, Mich., Track Races, Kalamazoo, Motor Speedway.
Nov. 16 and 18—Santa Monica, Cal., Vanderbilt Cup and Grand Prix Races.

GOOD ROADS

Sept. 6-7—St. Paul, Minn., Good Roads Congress, Auditorium.

SHOWS

Sept. 2-9—Columbus, Ohio, Fall Show, Ohio State Fair, Columbus Automobile Show Co.

TRACTOR

July 17-21—Dallas, Tex., Tractor Demonstration.
July 24-28—Hutchinson, Kan., Tractor Demonstration.
July 31-Aug. 4—St. Louis, Mo., Tractor Demonstration.
Aug. 7-11—Fremont, Neb., Tractor Demonstration.
Aug. 14-18—Cedar Rapids, Iowa, Tractor Demonstration.
Aug. 21-25—Bloomington, Ill., Tractor Demonstration.
Aug. 28-Sept. 1—Indiana Tractor Demonstration.
Sept. 4-8—Madison, Wis., Tractor Demonstration.
Sept. 11-16 — Milwaukee, Wis., Fall Show, Wisconsin State Fair, Milwaukee Automobile Dealers.

The Week in the Industry

Mountain Trade—The Adamson-Purinton Motor Co. is the name of a new concern at 1320 Broadway, Denver, which has secured the Dixie and Old Hickory truck agency for northern Colorado. Adamson is one of the proprietors of the South Denver Garage, 271 South Broadway.

The Colorado Motor Car Co., 1520 Broadway, Denver, Cole, Reo and Saxon distributor for Colorado and Wyoming, has opened a branch for used cars and service station in a new building at 801 Broadway.

The Chandler Motor Co. of Colorado, 1518 Broadway, Denver, Chandler distributor for Colorado and Wyoming and Stutz dealer for Denver and vicinity, is now in charge of G. W. Embrey, formerly of the Chandler factory. Embrey has been connected with this company from the time it started and held a service department position just before taking over the management of the Colorado branch.

The McQuay-Norris Mfg. Co.'s Denver branch, 528 First National Bank Building, handling piston rings and lyanite pistons, is now in charge of H. W. Sweeney. H. W. Knapp, whom he succeeded as local manager, has been transferred to the Kansas City branch.

De War Bros., new Denver agents for the Detroit Electric, have just completed a new building for salesroom and service station at 749-751 Broadway.

The Mid-West Rubber & Auto Co., 1606 Broadway, Denver, distributer of Pennsylvania Vacuum Cup tires for Colorado, Wyoming and New Mexico, has secured the Davis car distributing agency for these three States.

Trade News from Pa.—William Patten, of the Patten-Fleming Co., 1828 Market Street, Philadelphia, dealer in automobile accessories, has asked for a receiver for the business. Mr. Patten is withdrawing from the firm, but could come to no agreement with G. G. Fleming. The assets are $7,121 and the liabilities $5,677.

The Times Square Automobile Co., New York, has leased the entire first floor of the building at the southwest corner of Broad and Vine Streets, Philadelphia. The company, which has showrooms in a number of other cities, is having alterations made to the new one here.

The General Refractories Co., West Decatur, Pa., has awarded contracts for a one-story brick and steel factory building, 115 by 300 ft. The Johns-Manville Roofing Co. received the roofing contract.

Trade Happenings

The King Car Agency, 514 North Broad Street, Philadelphia, has taken additional quarters at Broad and Brandywine Streets.

The Industrial Bureau of the Philadelphia Chamber of Commerce is negotiating with several large manufacturers with a view to having them establish plants in this city. One of these is a group of New York and Detroit capitalists who are seeking a plant here to make kerosene for automobiles. The other is the Houk Wire Wheel Co. of Buffalo, which is also considering a branch factory here.

Ohio News Items—Papers have been filed by the Miller Rubber Co., Akron, for an increase of the authorized capital from $2,000,000 to $20,000,000. In filing the papers a fee of $18,000 was paid into the State treasury. The increase will be used for betterments and extensions.

J. M. MacDowall, formerly of Pittsburgh, has been made manager of the retail branch of the Ohio Electric Car Co., at 1220 Madison Avenue, Toledo.

The Willys-Overland Co. of Toledo has taken a lease on part of the former factory of the Columbus Buggy Co., on Dublin Avenue, Columbus, which will be used for the storing of cars for the present. Later, an assembling branch may be established.

Samuel Isaacs, formerly with the O. G. Roberts Co., Columbus, Overland agent, has taken a position with the Oscar Lear Motor Car Co., central Ohio agent for the Buick.

Gaston Goes to Lexington—H. W. Gaston, formerly assistant manager of the Eastern branches of the Reo Motor Car Co., has been appointed sales manager of the Lexington Motors New York Corp., with headquarters in the Circle Building. This corporation controls the Lexington output in New York, New Jersey, Connecticut and **Rhode Island.**

Ill. News—The Jennings Auto Sales Co., Springfield, has moved into a new building at the corner of Tenth and Adams Streets. A salesroom and all modern conveniences have been installed for the comfort of patrons. The rear will be devoted to a service station and the second story for storage purposes.

The Keyt-Erb Automobile Co., Rockford, has removed to the Countryman Building, corner of Main and Cedar Streets, due to the necessity for larger quarters, and the new plant will be utilized for a sales agency and repair department. The building will be devoted to a service station.

W. Y. Wayne, Decatur, has opened a paint shop for automobiles and motor vehicles of all kinds at 405 East Center Street. This is a new departure, as most of the vehicle paint shops have been taking care of cars as a side issue.

The Waite Tractor Co., Elgin, Ill., has taken over the entire manufacture of its tractor machine in the Kimball Street plant, Elgin. The machinery is now being installed in Elgin. Eight more men will be added to the Elgin plant by the change. Under the contracts in effect when the company located in Elgin the first of the year, part of the construction took place in Elgin and the remainder in Waukesha. By consolidating at Elgin better results are anticipated. About 250 tractors will be placed upon the market this year.

New England Trade Items—H. Strahan, S. A. S. Strahan and P. J. Dimond have formed the Crow-Elkhart Motor Co., Boston, Mass., with salesrooms at 1121 Commonwealth Avenue.

F. W. Paine and G. H. Russell have organized the Paterson Motor Car Co., Boston, for the Paterson six.

J. E. Cunningham, for 5 years with J. W. Maguire, Pierce-Arrow dealer at Boston, has resigned to become manager of the Republic Motor Truck Co., in that city.

The De Luxe Sales Co. has been organized at Boston, Mass., to build special bodies for Ford cars. H. H. Murphy is manager, and the salesrooms are at 1123 Commonwealth Avenue.

The B. F. Goodrich Co. has opened a new factory branch at Burlington, Vt., with L. E. Stone as manager.

The E. E. Wentworth Co., agent for the Overland in Maine, has outgrown its quarters at Portland and has moved into larger ones there.

C. R. Culver, who now has the Pierce-Arrow agency at Springfield, Mass., is planning to erect a new sales and service station at Hancock and State Streets. The Stoddard Motor Co., that handled the line for years, will take on another well-known make.

G. W. Geiger, formerly selling Kissel-Kars and Mitchells at Springfield, Mass., has resigned to join the Stearns-Knight agency there.

C. M. Stone, agent for the Davis line at Providence, R. I., has moved.